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RESIDUAL EFFECT OF FERTILIZERS

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If the soil is low in available plant foods the application of fertilizers show responses in the crops produced, whereas little effects in crop increases are shown for fertilizers where the soil is high in available plant foods. This statement may be made irrespective of the total plant foods contained by the soils. In general the greatest effect from all fertilizers is shown for the season during their application and in many cases there is no residual effect carried over into the second or subsequent years. This is especially true of the fertilizers carrying nitrogen either as ammonium or nitrate nitrogen. However, fertilizers carrying nitrogen in organic combinations such as green cover crops or farm manures generally show some residual effect for one or even for several years after the application, depending upon the amount added.

When fertilizers are added to soils the immediate effect upon crop production and the possibility of the fertilizers exerting residual effect upon subsequent crops is influenced by the base exchange properties of soils. Potash and phosphate fertilizers are fixed to a very great extent by soils. The fine textured soils have the power of fixing the greatest quantity of fertilizers. The basic radicals of fertilizers all have the power of being more or less firmly fixed by soils in a relatively short time after their application. As an example of this, ammonium nitrogen, potassium or calcium can be fixed by soil due to the base exchange properties of soils as above mentioned. The phosphate radical is also firmly fixed by soils whereas the sulphate is only loosely fixed, and the nitrate is subjected to little if any fixation. Nitrogen fertilizers can not be expected to exert residual effects after the year of application unless organic matter has been the source of the nitrogenous fertilizers used.

These brief statements give a general idea of the results to be expected as arising from residual effects of fertilizers, which have been previously applied. It should be further stated that such crops as legumes have greater power to obtain and utilize fixed plant foods from soils than have the cereals and the grasses.

This brings us to the point of what might be expected when fertilizers are applied before the various crops. Whenever fertilizers are applied to soils they are dissolved to a greater or less extent by soil water. This water comes in contact with the various soil particles and the process of fixation immediately begins. The soil water bathes the soil particles and a thin film is spread over a large surface area. Thus the fixation gives rise to a large surface of a fixed quantity of the fertilizer, permitting the fertilizer to subse-

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quently be more easily made available than could a similar quantity of the fertilizer from the parent soil material. It is quite apparent that the fertilizer can be more effective when it is applied at the same time as the seed is drilled, and as near as possible to the seed, otherwise the fertilizer is fixed to a greater extent and can subsequently be utilized by plants only at a slower rate.

The above statements may be summarized as follows:

(1) Fertilizers will show greatest benefits the first year.

(2) There may or may not be any effect in subsequent years, depending upon soil condition and the kind of crop grown.

(3) We might expect residual effects from such fertilizers as phosphates, potash, organic manures or lime, whereas little if any residual effect should be expected from ammonium or nitrate nitrogen.

(4) Certain crops like the legumes should show greater responses from the residual effects of fertilizers than would crops like cereals or grasses.

The most economical amount of fertilizer to apply will depend upon such conditions as the time of application, method of application (drilled with the seed or broadcasted) and the nature of the soil. Very heavy textured soils have greater fixing powers than have the lighter soils, and larger fertilizer applications may be profitably used on the heavier textured soils. Fertilizer requirements will have to be determined for the different soil areas. If we consider the question of phosphatic fertilizers the following relationship should be pointed out. A 50 bushel crop of wheat requires about 15 pounds of phosphorus for the grain and straw, and a 4 ton crop of clover requires about 20 pounds of phosphorus. There are at least 20 pounds of phosphorus in 100 pounds of treble superphosphate. The crop can be expected to obtain at least a part of its phosphorus from that already contained by the soil. Thus it would seem that in many cases a 50 pound application of treble superphosphate would be adequate for the average crop produced. Any surplus phosphorus from the fertilizers which is not used by the crop becomes an addition to the soils store of this plant food and can be drawn upon by subsequent crops in exactly the same manner as the phosphorus originally found in the soil. These relationships have been shown by experiments conducted by various investigators, (*1*). Data obtained from experiments conducted in Alberta also very clearly show the residual effects of fertilizers.

Field Experiments

The following experiments will show the effect of fertilizers upon the crops during the year of the fertilizer application, as well as for the first year subsequent to the fertilizer application. These results are the averages obtained from coöperative experiments with farmers and from our experimental plots at the Breton field.

Table 1 contains results for the years 1929 and 1930, and represents the effects of fertilizer applications as expressed in crop increases for the year during which the fertilizer was applied. From the data in table 1 it is evident that significant increases were obtained from the application of fertilizers to both the black and the wooded soils for both years. It is also significant

that the ammonium phosphate is the better fertilizer, especially for the wooded soils. In fact for cereals on our wooded soils nitrogen is in greater need than phosphorus, especially after the first few crops have been produced.

On the Breton Experimental plots the application of fertilizers have changed the yields of the cereals as follows:

Wheat from 14 to 24 bushels, an increase of 71 per cent.
Oats " 25 to 43 " " " " 72 "
Barley " 21 to 41 " " " " 95 "

These increases refer to the year during which the fertilizers were applied and the greatest increases for the cereals under field conditions were experienced when nitrogen fertilizers were applied.

TABLE 1.—*Average increases for fertilizers applied in 1929 and 1930. (Bu. per acre).*

Soil	Fertilizer Applied	1929		1930		
		Wheat	Oats	Wheat	Oats	Barley
Black soil	Superphosphate	9.7	11.8	5.1	7.8	.....*
" "	Ammonium phosphate	9.1	.....*	7.0	11.9	.....*
Grey Wooded soil	Superphosphate	3.7	4.7	2.1	2.7	2.1
" " "	Ammonium phosphate	5.9	4.5	6.0	12.2	15.9

* Ammonium phosphate not applied.

Wheat yields were taken from several of the plots for both 1929 and 1930, but fertilizers were applied to these plots only in 1929. Fertilizers were applied to other plots in 1929 and legumes seeded, but yields were taken from the legume plots only in 1930. The data from these plots are reported in table 2, and indicate the effect of the fertilizer upon the wheat crop both during the year of the fertilizer application and the year subsequent. However, yields were not taken from the legume plots during the year of fertilizer application, and the table shows only the residual effect for the year subsequent to fertilizer applications.

It is quite apparent from these results that there is a slight residual effect for the cereals, but that the residual effect is of a smaller magnitude than the direct effect. In only one case is the residual effect very great. However, it is to be expected that under certain conditions the residual effects from these fertilizers could very possibly be greater than the results obtained by us. In considering the results obtained from legume crops, it should be first stated that in none of the above experiments were yields taken during the first year. However, in another set of experiments we will show the residual effect of fertilizers as expressed in increased crop yields for legumes for both the first and second year after fertilizers have been applied, as compared with the year of application. The increases shown in table 2 for the legume crops are decidedly significant when it is considered that these increases represent only the results obtained from the first cutting. It should be further added at this point that legume crops properly inoculated have the ability to fix their own nitrogen, and for such crops there is no nitrogen problem even on the wooded soils.

TABLE 2.—*Average increases for fertilizers during year of application and residual effects for subsequent year.*

Soil	Crop	Fertilizer Applied	Increases for fertilizers for year of application (Bu. per acre)	Increase due to residual effect of fertilizers. (Bu. per acre)
Grey transition wooded soil	Wheat	Superphosphate	6.3	1.6
Black soil	Wheat	Superphosphate on fall plowing	5.2	0.6
" "	"	Ammonium phosphate on fall plowing	9.1	1.3
" "	"	Superphosphate on fallow	18.8	5.0
				(Lbs. cured hay 1st cutting only)
Grey wooded soil	Alsike	Superphosphate	no crop harvested	929
" " "	"	Super. + lime	" " "	1303
" " "	Altaswede	Super.	" " "	884
" " "	"	Super. + lime	" " "	2564
" " "	Alfalfa	Super.	" " "	1184
" " "	"	Super. + lime	" " "	1213

The above increases were obtained as a result of the application of 100 pounds of phosphatic fertilizer per acre. In our opinion further increases as a result of residual effects will be shown for these same legume crops in 1931, and possibly in 1932. This opinion is formed as the result of other experiments conducted by us.

GREENHOUSE EXPERIMENTS

Experiments have been conducted in the greenhouse with wooded soils for a period of 6 years. Sixteen different crops have been produced from 3 series using virgin soil to begin with and applying N, P, K, Manure and Lime, singly and in combination. Barley, oats, wheat, sweet clover and red clover have been grown. For a detailed statement of these experiments the reader is referred to a previous paper (*2*). Only the results obtained from two crops and extending over a period of 3 years will be presented in the present paper. Most of the data in tables 3 and 4 have been obtained subsequent to the 1928 report.

In the upper part of table 3 the average yields of wheat and clover are reported as grams per pot. The increases for fertilizer treatments have been computed and are shown in the lower part of the table as proportional increases where the checks are expressed as 100.

From table 3 it is clearly seen that there are considerable increases in the wheat yield for the year during which the fertilizer was applied (the greatest increase was 64 per cent above check). Except for manure there is very little residual effect from fertilizers in the second year and no residual effect in the third year, (less than 10 per cent increase is not considered significant).

However, the increases are much greater with the clover crop than with the wheat crop. Here again the greatest increases are shown for the year

TABLE 3.—*Residual effect of fertilizers on wheat and clover. Gray wooded soil. (Yields as grams and proportional increases where checks expressed as 100).*

	Fertilizer Treatments						
	None	Nitrogen	Lime	Manure	Phosphorus	Lime and Phosphorus	Mixed Fertilizer
	Weight in grams per pot						
Wheat Fertilizers applied	3.2	3.8	4.8	3.8	5.2	5.2	4.4
" 2nd crop after fertilizer	3.4	3.4	3.8	4.6	3.9	3.8	3.6
" 4th " " "	2.5	2.5	2.7	3.2	2.5	2.7	2.3
Clover Fertilizer applied	3.9	5.1	6.3	21.4	17.3	18.8	14.2
" 2nd crop after fertilizer	11.4	11.7	19.7	31.9	34.6	32.7	25.6
" 3rd " " "	11.6	11.3	19.5	24.9	36.9	34.4	24.6
Proportional increases where check expressed as 100.							
Wheat Fertilizer applied	100	121	151	116	164	164	141
" 2nd crop after fertilizer	100	100	111	134	112	111	106
" 4th " " "	100	100	108	128	100	108	93
Clover Fertilizer applied	100	132	164	556	449	488	370
" 2nd crop after fertilizer	100	103	173	281	305	290	225
" 3rd " " "	100	98	169	216	319	300	213

during which the fertilizer was applied (the greatest increase was 456 per cent above the check), but unlike the wheat crop the clover has been materially increased during the second and third years after the fertilizers were applied. These increases in the clover during the second and third years are due to residual effects of the fertilizer and amount to from 100 to 200 per cent over the check. These increases due to residual effects of fertilizers are shown in figure 1. (See also figure 3).

After the crop of clover shown in figure 1 had been harvested a second cutting was permitted to grow. This was turned under in green condition so that the effects of clover might be shown in a subsequent wheat crop. In a second series of clover which had been fertilized one year previous to that shown in figure 1 (or 3 years previous to the clover) the first cutting was also harvested and the second cutting turned under. Wheat was likewise grown on a third series which had no clover turned under. The results of the wheat yields for these three series are reported in table 4.

TABLE 4.—*Residual effect of fertilizers on wheat where clover is turned under. Gray wooded soil. (Yields of wheat in grams).*

	Fertilizer Treatments						
	None	Nitrogen	Lime	Manure	Phosphorus	Lime and Phosphorus	Mixed Fertilizer
Wheat—4th crop after fertilizers No clover turned under.	2.5	2.5	2.7	3.2	2.5	2.7	2.3
Wheat—3rd crop after fertilizers Clover turned under.	7.0	6.6	10.3	12.4	14.8	15.3	11.1
Wheat—4th crop after fertilizers Clover turned under.	7.3	7.2	10.4	11.9	14.2	14.2	12.0

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Figure 1 Clover showing residual effects of fertilizers. This is the second crop after the fertilizers had been applied. The average yields for three pots from this series are recorded in table 3, line 5. The increases due to residual effects are as follows: nitrogen none, lime 73, manure 181, phosphorus 205, lime and phosphorus 190, mixed fertilizer 113 per cent respectively. The yields from the best pots are about three times those from the checks. The second cutting from these pots was turned under for the wheat crop reported in table 4, line 2. See also figures 2 and 3.

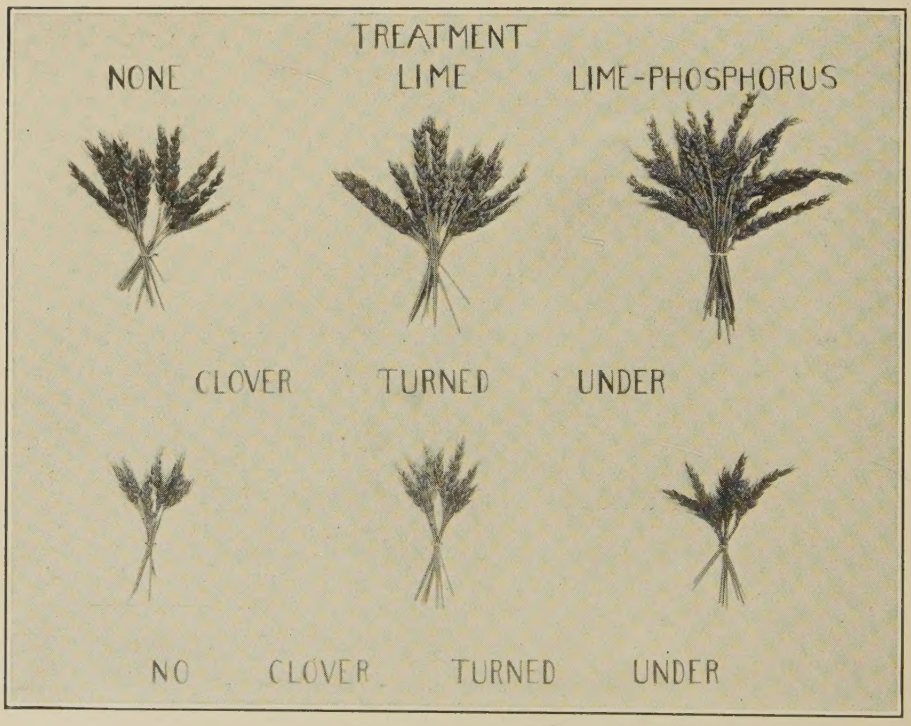

Figure 2. Residual effects of fertilizers on wheat where clover has been turned under compared with no clover turned under. Note the size and number of heads. In each case the wheat shown in figure 2 is the fourth crop after fertilizers. The yields for these pots are recorded in table 4, line 3 and line 1. Comparing vertically shows the direct effect of turning under clover whereas a horizontal comparison shows additional residual effects from the fertilizer.

By comparing the yields in table 4 it will be seen that the checks where clover had been turned under (column 1) gave almost 3 times as much wheat as where no clover had been turned under; that the residual effects of fertilizers on the clover had been carried over to the succeeding wheat crop to the extent that some of the yields were at least twice as great as the checks, (compare columns 1, 5 and 6). In other words the combined effect of clover and the residual effect of fertilizers gave six times as much wheat as where no clover had been turned under, whereas clover without fertilizers showed only about three times the wheat produced from no clover and no fertilizer. Of course it must be kept in mind that more clover was turned under for the

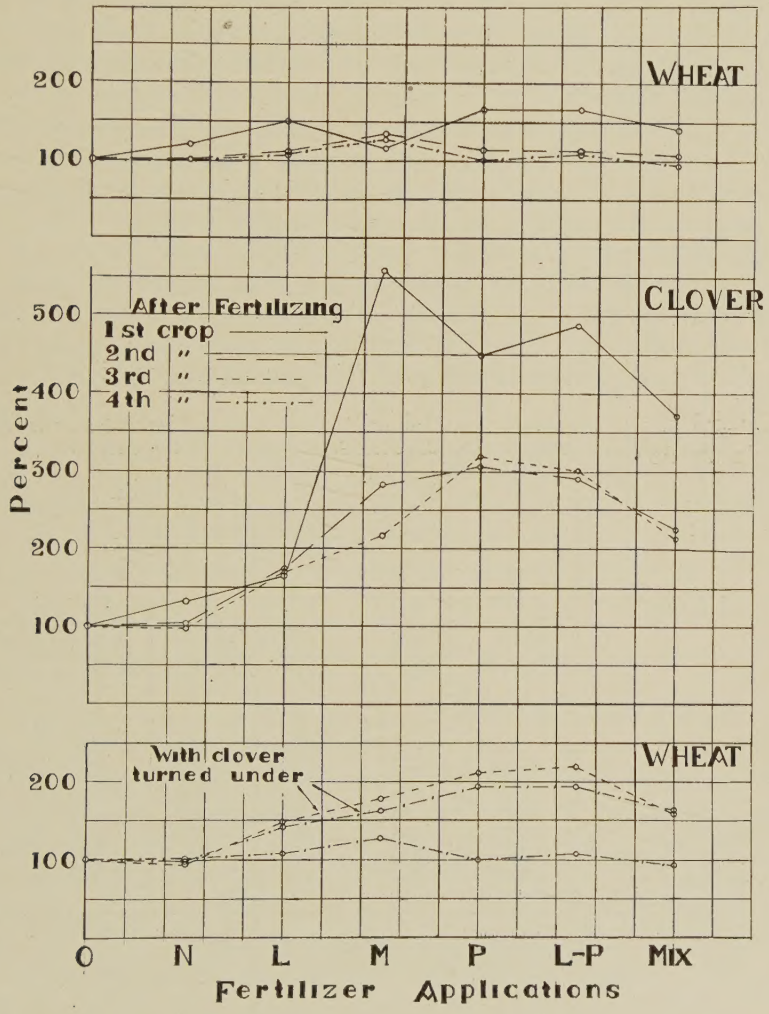

Figure 3. Proportional crop increases due to direct and to residual effects of fertilizers. The curves in this graph represent the data in tables 3 and 4 when expressed as per cent increases over the checks. If the actual yields had been plotted the two broken line curves for clover would actually fall above the solid line curve (see data in upper part of table 3) and the two upper curves in wheat (lower part of graph) would be from 3 to 6 times as far above the origin as would the lower curve (see table 4).

fertilized pots than for the checks, but the greater growth of clover was due to the effects of fertilizers which had been applied two and three years before the clover crop.

A better idea of the differences in appearance of the wheat actually grown in some of the pots is obtained by referring to figure 2.

The data from tables 3 and 4 are shown as proportional increases in the curves of the graph, figure 3.

Effect of Fertilizers Upon the Composition of Crops

Direct and residual effects of fertilizers are shown not only in the yields but also in the composition of crops. The effects of fertilizers upon the composition of crops are shown by the data in table 5, which contains the per cent of phosphorus, together with the amounts removed from the soil by clover and wheat.

The upper part of the table shows the per cent of phosphorus in crops and the lower part the actual amount removed from the soil. There is a decrease in the per cent of phosphorous found in the clover which is roughly proportional to the increase in time after the fertilizer had been applied (compare horizontally columns 1, 2 and 3). This is shown by the following per cents of phosphorus in the clover for three years respectively; check .135, .105 and .082; phosphorus treatment .330, .314 and .220. The per cent of phosphorus in the clover from the checks is only about one third that found in the clover from the phosphated pot (line 1 compared with line 5).

Table 5.—*Per cent of phosphorus in clover and wheat, and mgs. of phosphorus in crops after various fertilizer applications to wooded soils. (Clover grown in 1928 and 1929, wheat 1930).*

Fertilizer Treatments	Phosphorus in Crops (per cent)					
	Clover			Wheat		
	Fertilized in 1928 crop grown 1928	Fertilized in 1928 crop grown 1929	Fertilized in 1927 crop grown 1929	Fertilized in 1928 crop grown after clover 1930	Fertilized in 1927 crop grown after clover 1930	Fertilized in 1927 crop grown 1930
None	.135	.105	.082	.343	.336	.500
Nitrogen	.105	.099	.073	.329	.336	.464
Lime	.128	.105	.074	.368	.376	.493
Manure	.157	.110	.097	.344	.376	.505
Phosphorus	.330	.314	.220	.432	.456	.505
Lime and Phosphorus	.271	.333	.287	.444	.438	.488
Mixed Fertilizer	.174	.133	.117	.427	.432	.482
	Phosphorus found in Crops (mgs. per pot)					
None	5.2	11.9	9.5	24.0	24.5	12.5
Nitrogen	5.4	11.6	8.3	21.7	24.2	11.6
Lime	8.1	20.7	14.3	37.9	39.1	13.3
Manure	33.6	35.1	24.2	42.7	44.7	16.2
Phosphorus	57.1	108.7	81.2	63.9	64.8	12.6
Lime and Phosphorus	50.1	108.9	98.7	67.9	62.2	13.2
Mixed Fertilizer	24.7	34.1	28.7	47.4	51.8	11.1

Wheat in general contains higher phosphorus contents with smaller variations than does the clover. However, the effect of phosphorus where clover is turned under is appreciably shown in the phosphorus content of the wheat (.34 against .44 per cent). The highest phosphorus contents were found in the wheat from the series which had not grown clover. Here a unit of phosphorus has been less effective in the crop produced than in the other two series, possibly due in a large measure to nitrogen deficiency.

Effects of fertilizers upon the amount of phosphorus utilized by crops is strikingly shown in the lower division of table 5. Where no phosphorus had been applied (check, nitrogen, lime) the wheat following clover removed about twice as much phosphorus from the soil as had the previous clover crops. In the case of the manure treatment the wheat also removed more phosphorus than did the previous clover crops, but for the phosphorus and phosphorus and lime treatments the clover crops removed much more phosphorus from the soil than did the subsequent wheat crops.

The residual effect of the fertilizer is shown in addition to clover by the amounts of phosphorus utilized by the wheat. Columns 4 and 5 show about 64 as against 24 mgs. of phosphorus in the wheat as the result of phosphorus fertilizer applied three years previous to the wheat. The wheat (check) where no clover had been turned under was able to remove only about one half as much phosphorus from the soil as where clover had been turned under and after the phosphate fertilizers the wheat following clover removed about six times the phosphorus that was removed by wheat without clover.

Improvement in the quality of the clover hay for feed as a result of fertilizer added to this soil is quite apparent, since a unit of hay from the fertilized soil contains three times as much phosphorus as a similar unit of hay from unfertilized soil. This higher phosphorus content of the hay together with the increased yields resulting from the application of fertilizers has given from six to ten times the phosphorus removed from the fertilized as from the unfertilized soil.

Summary

Fertilizers show greatest benefits for the year during which they are applied. There may or may not be any effect in subsequent years, depending upon the kind of fertilizer used, crop grown and the soil condition. Residual effects might be expected from such fertilizers as phosphates, potash or organic manures, whereas little if any residual effect should be expected from ammonium or nitrate nitrogen. Certain crops like the legumes should show greater responses from the residual effects of fertilizers than would crops like cereals or grasses. Fertilizer requirements differ materially and have to be determined for the various soil areas and the different kinds of crops.

From field experiments significant increases were obtained from the application of fertilizers to both the black and wooded soils for such crops as wheat, oats ,barley and legumes. There was a slight residual effect from the fertilizers for cereals, but the direct effect was of much greater magnitude. There was a decided residual effect on the legumes.

From the greenhouse experiments with wooded soils there were considerable increases in the wheat yields for the year during which the fertilizers were applied (the greatest increase was 64 per cent above check); except for manure there was very little residual effect in the second year and no residual effect in the third year. Increases in the clover were much greater than in the wheat. Here again the greatest increases were shown for the year during which the fertilizers were applied (the greatest increase was 456 per cent above the check), but unlike the wheat crop the clover showed increases amounting to from 100 to 200 per cent as a result of residual effects from the fertilizers. Clover turned under showed decided increases in the subsequent wheat crop; it gave three times the yields from the checks and again doubled the yields from the previously phosphated pots.

Direct and residual effects of fertilizers were shown in the composition as well as the yields of crops. The per cent of phosphorus in some of the clover was 3 times that of the checks. The yields were likewise 3 times as great. Thus some of the clover removed more than 9 times as much phosphorus from the soil as did that grown on the checks.

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OUR FARM PROBLEMS—AND SOME POSSIBLE SOLUTIONS*

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The office dictionary gives one definition of the term "problem" as a perplexing question demanding settlement,—especially when difficult or uncertain of solution. This definition will serve for our discussion. At the present time, Saskatchewan agriculture has its full share of trouble. Problems were numerous before the recent crisis, but their magnitude seldom or never approached that of the present time. Over a period of two or more decades, the prairies of the Dominion were developed and rapidly became established as important contributors to the world's supply of wheat. A "wheat complex" became the chief characteristic of Saskatchewan agriculture early in its history. Natural and economic factors combined to this end, and on the whole Saskatchewan farmers prospered. Occasionally lean years have been experienced, and hard times resulted. These storm periods were generally weathered more or less satisfactorily, and followed by brighter days. Certain areas, however, were found to be almost perennially disappointing, and many of them have become partially or completely abandoned.

For the few years preceeding the outbreak of the Great War, prairie farmers had been selling their wheat on the basis of from ninety cents to one dollar per bushel for No. 1 Northern at Fort William. The years of the war saw prices rising steadily until 1917, when the Dominion Wheat Board commenced its three year control of wheat marketing, during which prices ranged above the two dollar figure. Prices for the crop of 1920 had a very wide range, probably having an average of about two dollars per bushel, but the crops of 1921 to 1923 were sold at prices not much over the dollar mark. The short crop of 1924 obtained about $1.70 per bushel at Fort William for the premier grade, and the crops of the next three years slightly over $1.40.

The 1928 crop was a very heavy one of poor grade, and although all wheat prices were considerably lower there was difficulty in moving it. The effect of the big carry-over was felt in marketing the wheat grown in 1929, even though that crop was smaller and generally of better grade. Economic conditions, internationally complicated for many years, have increased marketing difficulties tremendously. To the wheat-growers of Saskatchewan, the most distressing feature is the serious decline in wheat prices so recently experienced. From $1.60 per bushel in July 1929, the average monthly prices of wheat have steadily sagged to $0.55 in December 1930, a drop of $1.05 per bushel in 18 months, or about six cents per bushel per month. This persistent decline has exceeded the most pessimistic forecasts. It has amounted to about 75 per cent of the highest grade price at the local elevators in Saskatchewan, or 4 per cent of this figure per month. The consequences of this situation are beyond the power of the grain grower to overrule. After costs of transportation and handling grain from the local shipping point to

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Fort William have been deducted, much of the grain delivered by the growers failed to bring the farmer 20 cents per bushel locally for the grade of wheat produced in 1930.

What has this done to the Saskatchewan farmer? In simple terms, it has simply wiped out the major part of the gross farm revenue from the 1930 crop year. To many Saskatchewan farmers, this has happened to his crop revenue before 1930,—but from other causes. We remember, within recent years, partial or almost complete losses of crops by some farmers from one or more of the following causes:— extreme frost damage, rust, weather, etc. In Saskatchewan we have been able to survive these visitations, and to some extent the psychology of the farmer is adjusted to these situations. They are part of the nature of things agricultural on the prairies, and although these losses are to be thought of as possibilities, yet these fears are usually offset by the expectations of what will come when bountiful crops are successfully harvested and marketed. During the past year, troubles have been brought about through a variety of economic conditions smashing the price of the commodity from which so large a part of the Saskatchewan farm revenue is derived. Few, if any, grain farmers have escaped the effects of this economic catastrophe, with which has come a sense of helplessness which is hard to dissipate. It helps little to know distress has been hard on industries other than agriculture, when our general condition is such that our own needs are so great.

The present time is opportune to examine the situation in Saskatchewan agriculture, and to present a few basic facts, and suggestions. This has been an open season for "economists" from all walks of life who have volunteered and even insisted on presenting plans to solve agriculture's problems, most of which our farmers consider inadequate or futile. A clear presentation of the problem, and an examination of pertinent facts, constitute an important step toward solution, when a solution is possible. If no solution is possible without radical readjustments, it is necessary to decide what changes are desirable and possible, and the best ways and means of effecting these radical changes. Although the title of this paper suggests the possibility of solutions being presented for the present problems, the major part of the paper will deal with the problems rather than with the solutions. Throughout this paper the point of view is that of the farm manager, and marketing references are included only insofar as they may be essential to the discussions.

During the past five years the department of Farm Management of this University has been studying Saskatchewan farm businesses. Detailed information has been collected in six different districts representative of our agriculture, and records of over 800 farm businesses are now in the possession of the department. Summaries of these studies have been published for Moose Jaw, Melfort and Alameda, and other reports will be published as soon as possible. During the summer of 1930, field work was done in the areas around Turtleford and Kindersley. Some data from these studies will be presented in this paper.

The importance of a business approach to farming is gradually being recognized, but is seldom meeting with the recognition it deserves. Agricul-

ture, when successful, operates on a permanent basis, and this means that the returns from investments of farm capital and labor are satisfactory. We regard the farm as the place where the farm operator can find the best market for his capital, as well as for his labor and managerial ability. Farm success varies tremendously with individuals and with regions. Consequently it is difficult to make general statements which really apply to any given person or place. The following statements should be given a broad interpretation, and not be judged by comparison with any single farm. We will first consider a summary of the costs of producing grain crops, using the material from studies which have progressed sufficiently for this purpose.

Costs of production may be conveniently grouped into two classes—(1) Cash costs,—for which either cash is expended, or short term credit is secured, and (2) Non-cash costs—for which the returns may be partially or completely lacking, when conditions are unsatisfactory. The important non-cash costs are interest on the owned-capital invested in the farm, and the returns for labor and management of the operator and unpaid members of his family. On the majority of farms depreciation of capital is usually offset by new purchases. The cash costs of this discussion have been adjusted to take care of depreciation, and also of increases in inventory.

As over eighty per cent of the gross receipts on these farms came from sales of wheat, and ten per cent from the sales of the other crops, and only about six per cent from sales of livestock and livestock products, we shall not go far astray in assuming these farms to be operated entirely for crop production, and presenting the following statement of costs of producing Saskatchewan grain crops.

TABLE 1. *Cost of producing Saskatchewan grain crops.*

Based on studies of the Department of Farm Management, University of Saskatchewan—421 farms in 4 districts for crops of 1925, 1926 or 1927.

Average areas of crops per farm—312 acres (wheat 202).

Average yield of wheat—26.8 bushels of wheat per acre.

(sales 25.3 bushels of wheat per acre).

Average farm price per bushel of wheat—$1.1567.

64% of crops were wheat—90% of receipts from crops sales were from wheat (only 71% of crops directly revenue producing).

	Per Farm	Per acres of crop	
Cash costs	$3,212	$10.29	
Non-crop cash receipts (livestock) products, sales, outside labor, etc.	827	2.65	
Net cash costs	$2,385	$ 7.64	(1)
Non-cash costs (includes wages of operator, interest on capital)	$2,417	$7,75	(2)
Total costs	$4,802	$15.39	(3)
Cash living costs (of family and operator)	534	1.71	

As some crop costs vary with the yields obtained, estimates have been made to bring these costs in line with the annual provincial average yield of 16.5 bushels per acre. A simple reduction by one-third of the amounts expended for paid labor and board, automobile, machinery, twine, and threshing has been made, which brings a total reduction of $677 per farm, or $2.17 per acre of crop. When these amounts have been subtracted from the net cash costs shown in this statement the figures are,—per farm $1708, and per acre, $5.47.

In this group of cash costs no consideration has been given to payments made for interest on borrowed funds or reduction of capital indebtedness. Reference will be made to costs of indebtedness later.

To cover the cash costs the crops which produce the revenue (71% of the total crop area of these studies) must produce at least $\frac{\$5.47 \times 100}{71}$ or $7.70 per acre. This amounts to about 51 cents per bushel of wheat (on the basis of 15 bushels sold per acre).

To cover all costs of production on the average yield basis the crops must return $18.62 per acre, or $1.24 per bushel of wheat. Obviously in 1930, cash costs of production have not been returned on the majority of Saskatchewan farms, and in few cases have grain farmers received anything towards non-cash costs.

The statement on general costs of production includes producers of all grades of efficiency, and costs range from the extremely low to the very high. Many of our Saskatchewan farms are operated inefficiently, but we have also our share of low-cost producers. With continued use of our lands for grain production, our costs are gradually increasing from a variety of causes such as soil troubles, weed-infestation, plant diseases and insect pests. Total costs per acre vary only slightly with yields, but costs per bushel decrease definitely with increase in yields. There is wide variation in costs of operation of similar farms in any district, and efficient farm operation, although limited in scope, brings all the advantages that may be obtained for the district within which the farm is situated.

An analysis of the costs of production, as shown by reports obtained from four areas in Saskatchewan, is presented in the following table, and in diagram 1.

TABLE 2.—*Cost of production of wheat on 421 Saskatchewan farms for crops of 1925, 1926 or 1927.*

Range of costs of production cents per bushel	Percentage of all farms which produced at this cost
Not over 40	6
41 to 60	11
61 to 80	26
81 to 100	24
101 to 120	14
121 to 140	7
141 to 160	5
Over 160	7

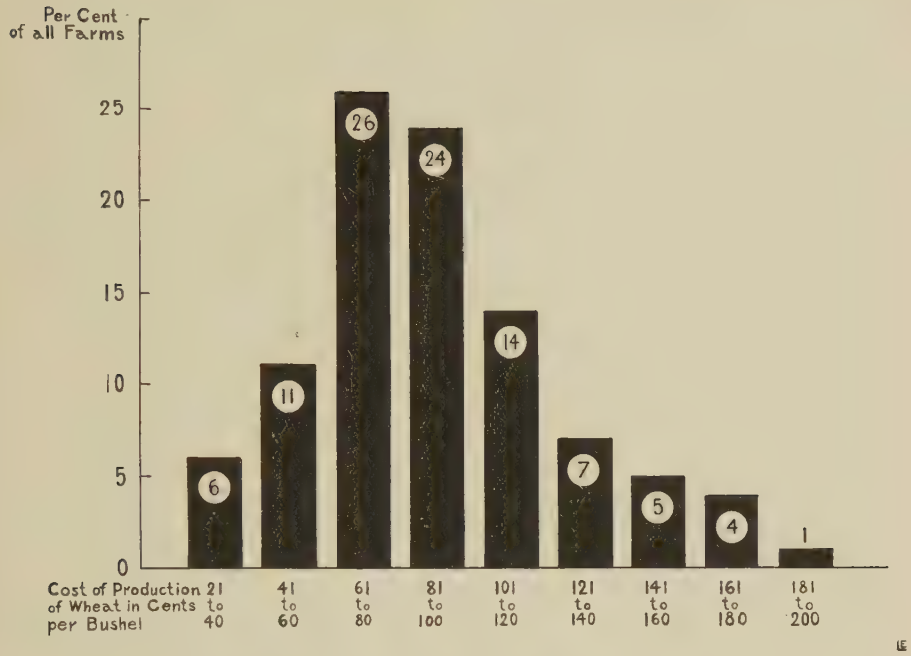

Diagram 1. Distribution of Farms according to Cost of Production of Wheat on 421 Saskatchewan Farms, for Crops of 1925, 1926, or 1927.

The heaviest concentration in this distribution is where costs range from 61 cents to $1.00 per bushel. On two-thirds of these farms the costs of production of wheat did not exceed $1.00 per bushel, and for one-half of these farms did not exceed 85 cents per bushel. On 12 per cent of the farms production costs were not greater than 50 cents per bushel. On the other hand, costs of production on one-third of these farms exceeded $1.00 per bushel.

The farms producing wheat at the lowest costs were able to do so because of extremely favorable conditions during the seasons for which these farms were studied. These fortunate conditions were exceptional, however, and higher costs can hardly be avoided on these farms for most years. The value of information on costs of production for any single year is limited. The most important thing to recognize is that, for any district, there are very considerable differences in costs of wheat production on the farms within that area. These differences are due, in part, to natural causes, but in larger measure to differences between farm businesses, i.e.,—the farms operated, and the people who operate them. Not all have equal opportunities. Some farms have become fairly fully and efficiently developed, and others have made little progress in that general direction. Burdens of many kinds handicap some operators, whereas others are comparatively free. Indebtedness makes heavy annual demands from some farm businesses, whereas others find demands from this quarter negligible.

The credit problem is becoming increasingly serious in Saskatchewan. Although time does not permit a detailed discussion of the credit problem in this paper the following information collected by this department during the summer serves to illustrate the conditions of the farmers generally in two areas of Saskatchewan.

The Turtleford study contained reports of 164 farms that could be used in this tabulation and the Kindersley study 202 farms. In addition there were other farms where the actual amounts of indebtedness could not be definitely ascertained. Many deals had been made involving purchases for land on the basis of stated quantities of wheat, and so uncertain were the operators of their remaining obligations that some of the reports had to be omitted from this section.

Farms in the general districts around Turtleford had an average area of 216 acres of crop land, and around Kindersley about 446 acres. The ranges of sizes are wide in each area.

On the open prairie of the Kindersley district many large farms have developed, and tractor farming is much in evidence, whereas the Turtleford country has many serious natural obstructions to large scale farming. The terms of occupations of farms by the present operators are fairly similar in the two areas. Capital per farm is 50 per cent greater at Kindersley than at Turtleford, and indebtedness is over 110 per cent greater. Loans have been granted more freely to Kindersley farmers than to those at Turtleford. In some cases the debt exceeds the total farm capital.

Table 3 presents a summary of the indebtedness of the farmers in those two areas.

TABLE 3.—*Farm Debt—for two districts in Saskatchewan as of July 1930.*
(Farms grouped according to years of occupation).

Years on farm	Total farms in group	Farms with debt	*Average total farm capital	*Average debt	*Debt as percentage of total capital
Turtleford					
0 to 5	27	25	$ 7,058	$2,833	40.1
6 to 10	26	26	8,645	2,638	30.5
11 to 15	29	25	11,038	1,925	17.4
16 to 20	29	24	11,647	1,577	13.5
21 to 25	53	49	15,447	2,347	15.2
All farms	164	149	$11,536	$2,262	19.6
Kindersley					
0 to 5	51	50	$10,860	$6,551	60.3
6 to 10	25	24	15,289	4,787	31.3
11 to 15	30	27	18,448	3,503	19.0
16 to 20	42	38	18,375	4,077	22.2
21 to 25	54	48	23,067	4,450	19.3
All farms	202	187	$17,361	$4,804	27.7

* Based on total farms of group.

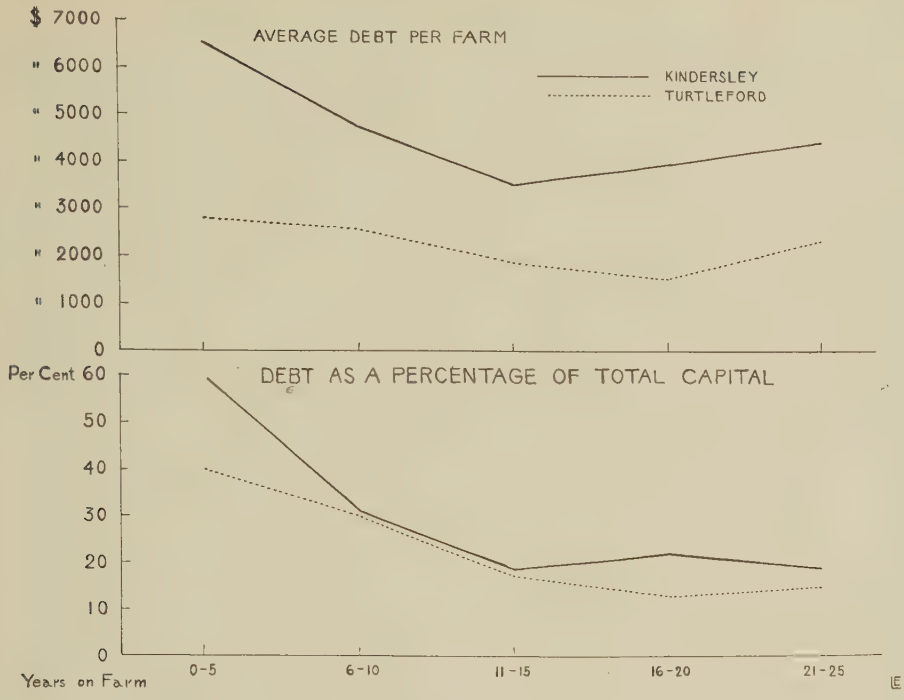

Diagram 2. Farm Debt for two Districts in Saskatchewan, July 1930. Farms are grouped according to years of occupation.

Data from table 3 has been presented in diagram 2, showing average debt per farm and average farm debt as a percentage of the average farm capital for the various terms of farm operation.

On most of this indebtedness 8 per cent interest is being charged. At Kindersley 80.7 per cent of the debt is in the form of mortgage on farm real estate, 7 per cent for farm implements, 8.6 per cent for bank loans, and 3.7 per cent miscellaneous, mostly for store bills. At Turtleford the proportions of debt were as follows:— mortgage on real estate 66.3 per cent, for farm implements 8.3 per cent, to banks 8.7 per cent, and miscellaneous 16.7 per cent.

Much of the land was valued by the operators at prices exceeding those at which it was bought, whereas the actual values in production are considerably lower. Farms acquired during the past 10 years carry high proportions of debt to farm capital, even on the basis of the comparatively high prices paid for land. On the basis of the actual values of the lands in production, the real proportion of debt to capital would be materially higher. Farm lands can seldom be paid for entirely out of their earnings, and when 8 per cent has to be paid on the debts incurred to acquire capital, a good deal of funds for payment of interest and principal has to come from other sources. The heavy burden of indebtedness, amounting to from 30 to 60 per cent of the farm capital for the groups having commenced operations on these farms during the past 10 years, are probably impossible ones for many of these farmers. The average debt per farm of the different groups, is not widely different in their respective districts, but the larger farms of the operators with the longest terms of occupations, make the burdens relatively

lighter than for those whose term of occupation is shorter. Our need for serious study of farmers' indebtedness, and of farmers' progress is very great.

As returns from farming have varied so much from year to year, the department of farm management has collected and summarized information to show annually the condition of the farmer of central Saskatchewan. The area selected was the Provincial Crop District Number 6, which includes about 13,000 square miles of wheat-farming land. This is the crop district in which Saskatoon is located. Official statistics of the Provincial Department of Agriculture, and of the Federal Census have been drawn on freely to supply the basic data for these calculations.

The typical farm of this area is one of 320 acres, and it is for farms of this size that the computations have been made. Calculations for farms of somewhat larger area would not be very materially different from those reported in this study, as the same general relationship would be shown.

Official reports indicate that most of the income of the farmers of the area is obtained from wheat sales. On the half-section farm, wheat, plus a small amount of other crops sold for cash and approximately equivalent to wheat, occupied 157 acres. Some other crops are grown, but these are practically all fed on the farm.

Cash returns from wheat sales are determined by (1) the number of bushels sold, and (2) by the price obtained. The price paid to the growers is influenced by (a) the basic price of the standard grade, and (b) the grade of wheat grown on the farm. The acreage of wheat varies little from year to year, but fluctuations in yields, grades and basic prices are considerable. The important thing to the farmer is the total receipts obtained from the sales of wheat per acre, or from the whole crop.

TABLE 4.—*Index numbers of bushels of wheat sold per acre, farm price of wheat per bushel, and total receipts from wheat sold per acre.*

Year	(1) Bushels of wheat sold per acre (1909-1925 = 100)	(2) *Farm price of wheat per bushel (1909-1913 = 100)	(3) Total receipts from wheat sold per acre. (Base Col. 1xBase Col. 2 = 100)
1913	130	99.5	129.4
1914	73	150.7	109.9
1915	156	126.4	197.8
1916	99	226.0	225.3
1917	90	275.0	247.5
1918	71	272.2	194.5
1919	54	261.3	141.8
1920	48	231.1	110.6
1921	91	130.8	118.9
1922	101	128.5	130.3
1923	137	116.1	159.1
1924	32	191.2	61.5
1925	114	166.3	188.9
1926	79	158.1	124.3
1927	101	133.6	135.5
1928	147	105.6	155.5
1929	73	102.1	74.8
1930	80	47.3†	38.0†

* A composite price adjusted for grade.
† Subject to revision.

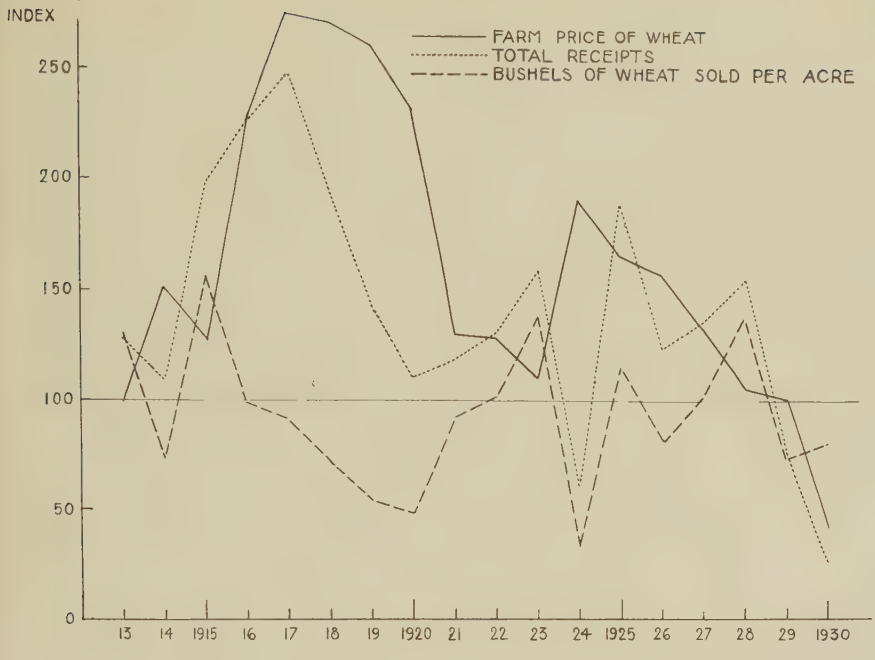

Diagram 3. Index Numbers of Bushels of Wheat Sold per acre, Farm Price of Wheat, and Total Receipts from Wheat Sold per Acre, For Saskatchewan Crop District Number 6—1914-1930.

Base of index of (1) bushels of wheat sold per acre: 1909-1925 = 100
(2) farm price of wheat: 1909-1913 = 100
(3) total receipts from wheat sold: base (1) × base (2) = 100

Table 4, and diagram 3, show data for Saskatchewan Crop District Number 6, in index form for (a) bushels of wheat sold per acre, (b) for prices paid to the farmer per bushel of wheat and (c) for total receipts from wheat sold per acre. Pre-war conditions are taken as the standard. (1909-1913 = 100 except for yield when the average for 1909-1925 was taken as the base).

The actual cash income from wheat varied tremendously. The lowest yields have been 1924, 1920, 1919, 1918, 1914, and 1929, with 1930 little better. Since the war the lowest prices paid farmers on the basis of the actual bushels they produced of all grades have been those for the last three crops.

The smallest cash receipts per acre, apart from 1930, came with the crop failure of 1924, and in 1929. The figures of table 4 are presented graphically in diagram 3 in order to show the relationship between wheat yield, its price per bushel and total receipts per acre. It is not possible to do more than mention a few of the other things which are significant to the farmers of this area. These include receipts from other sources, which, combined with receipts from sales of wheat, make up the gross farm receipts. Estimates of receipts from sales of livestock and livestock products are not known accurately. From data in the Dominion census reports, from official publications, and from studies made by the department, it has been possible to make a serviceable estimate for receipts from sources other than from wheat

sales. There is generally less variation in these non-crop receipts than is found with those obtained from crops sales. The estimates ranged from $258 per farm in 1913 to about $598 in 1929. When wheat growing has several years of fair prosperity farmers are apt to lose some of their interest in livestock, on the other hand after several poor years for wheat more interest is shown in livestock in this area. An index of the total cash receipts on these farms is presented in table 5, column 2.

To estimate the expenses incurred in operating these farms it was necessary to secure the coöperation of a considerable number of business men in the city of Saskatoon to supply us with records of costs of commodities for past years. We appreciate the generous help we have been given in all cases, which has enabled us to construct an index of cash expenditures for the 320 acre farm assuming that about the same quantities of these commodities were purchased annually. Actually, with changing revenues and changing expectations of revenues, purchases show considerable variation. With accumulation of indebtedness expenditures are further curtailed. We are satisfied, however, that the index secured for cash expenditures is roughly accurate, and suitable for the purpose for which it is used. Included in this index are expenditures for taxes, wages, hardware, twine, fuel, lumber, machinery, automobile, flour, and sugar, etc., in the proportion they would be made on a half section farm. This index appears in table 5, column 1.

Having constructed index numbers of total farm expenses, as well as those of total farm receipts, makes it possible to show the ratios existing between these two groups of items for each year. This ratio has been reduced to index form and serves to show the purchasing power of the total farm receipts for each year of the period of this study. The results appear in table 5, column 3. The material in this table appears graphically in diagram 4.

TABLE 5.—*Index numbers of farm expenses, farm receipts and purchasing power of the total farm receipts.*

Year	Index of expenses	(2) Index of total farm receipts	(3) Index of purchasing power of the total farm receipts
1913	100.0	100.0	100.0
1914	94.4	87.7	92.8
1915	98.3	149.4	152.0
1916	112.4	169.4	150.7
1917	150.9	185.8	123.1
1918	180.4	150.3	83.3
1919	194.6	114.9	59.0
1920	216.4	95.6	44.2
1921	191.8	99.4	51.8
1922	162.9	103.7	63.6
1923	169.1	126.4	74.7
1924	168.6	59.8	35.4
1925	170.2	151.8	89.1
1926	174.2	105.8	60.7
1927	176.2	118.4	67.1
1928	178.6	131.6	73.7
1929	171.4	76.7	44.7
1930	161.8	50.8	31.4

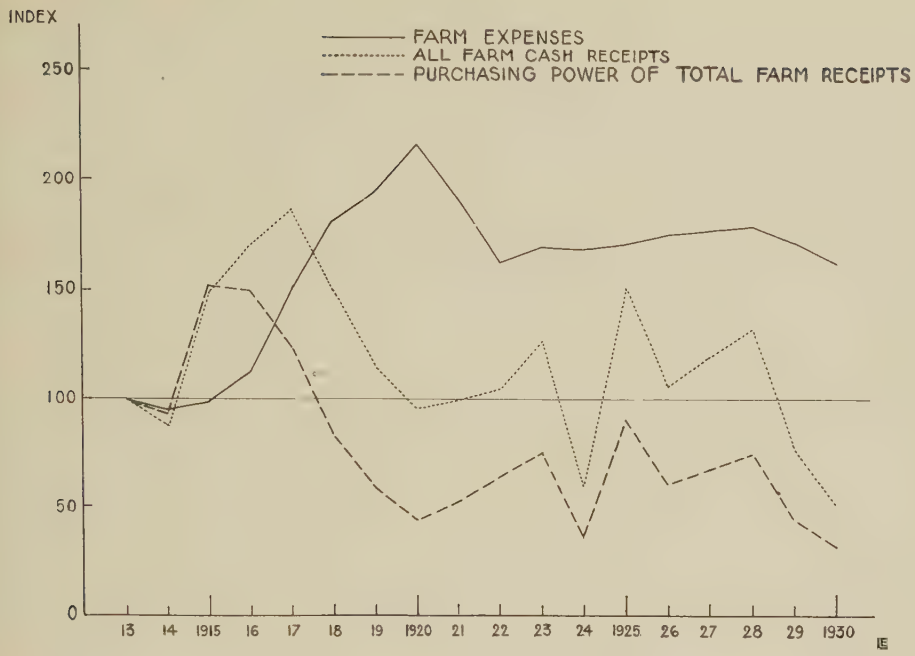

Diagram 4. Index Numbers of Farm Expenses, Farm Receipts, and Purchasing Power of the Total Farm Receipts, for Saskatchewan Crop District Number 6.—1914-1930.

Base 1913 = 100

The average index of farm receipts for 18 years (1913-1930) was 116. With the farm expenses index for this period at an average of 159, the averaging purchasing power of the total farm receipts was 73 per cent of the prewar year 1913.

The buying power of the Saskatoon farmer's income reached its maximum during the war years. In 1915, 1916 and 1917 the farmer could purchase the things he needed more freely than at any other time during the period of this study. In 1918, a poor crop, a slightly lower price than in the preceeding year, and the rapidly advancing prices of the commodities he had to buy, sent his buying power down below the pre-war level. Since 1918, the buying power has been continuously and seriously below that of 1913. The worst years have been 1930, 1924, 1929 and 1920 with several others almost as unsatisfactory. If the farmers of this area have maintained their earlier standards of living, they have done so out of past savings, or by going into debt.

Many farmers were unfortunate enough to buy farms when land prices were at the peak and dollars were cheap in terms of wheat. Those able to pay for their land with cheap dollars readily became established, but many who failed to pay these high prices with cheap dollars have since been required to pay the large amounts with dollars which are expensive in terms of bushels of grain. A general change in prices, with the prevailing relationships unchanged, affects only the settlement of past transactions and the buying power of money. A general fall in prices hits very hard those who are in debt, but helps those who have savings. The ideal condition for agriculture is to have the general price level slightly rising, with agricultural prices in harmony with the upward movement, as under normal conditions the farmer operates on some borrowed money.

In order to illustrate something of the changes which Saskatoon farmers have experienced in the buying power of their wheat, data on the number of bushels of wheat, and the number of acres of wheat required to pay for a binder, and to pay taxes on a 320 acre farm in the Cory Municipality, are presented in table 6.

TABLE 6.—*Quantities of wheat required to buy a binder, and to pay taxes on a 320 acre farm at Saskatoon (Cory municipality).*

Year	Required to buy a binder		Required to pay taxes	
	Bushels	Acres	Bushels	Acres
1913	240	13.2	64	3.5
1914	159	15.6	42	4.1
1915	181	8.2	51	2.3
1916	104	7.5	39	2.8
1917	93	7.4	42	3.4
1918	136	13.6	39	3.7
1919	140	18.5	49	6.5
1920	164	24.4	56	8.4
1921	345	27.1	110	8.6
1922	289	20.3	104	7.4
1923	334	17.4	130	6.8
1924	220	48.9	85	19.0
1925	232	15.2	101	6.3
1926	244	22.2	103	9.4
1927	288	20.3	120	8.4
1928	365	17.8	149	8 4
1929	374	37.0	145	14.2
1930	811	71.7	290	25.6

Comment on all phases of farm economics is not possible in a single paper. Some attempts have been made to touch on some of the important features. The purpose of farming is to secure returns from investments of capital and labor which will place the farmer in a position to live a full life. Liberty Hyde Bailey, the eminent agricultural writer, and former dean of the New York State Agricultural College, defines a successful farm as one (a) which gives the farmer a full and comfortable living from the soil, (b) which permits him to rear a family, comfortably and well, (c) which permits him to take his part in the life of the community, and (d) which enables him to leave his farm a little better than he found it. These four points are reasonable tests of success in farming.

Our farming communities have developed certain standards in our prairie civilization. Will our future returns from farming permit us to continue this development? No definite assurance of immediate recovery seems to be found, although recovery in wheat prices is to be expected, even though that recovery may be gradual. I would like to read to you a brief summary of the wheat situation written in the November issue of the Farm Economics by Drs. Warren and Pearson of Cornell University. "Wheat is worth about one-half as much as last year and prices have been running about 90 per cent of the prices before the war. The carry-over was large and the world crop was good. There are, however, other important factors.

One of the wildest periods of speculation that the country has ever experienced is in the process of liquidation. Few persons in this or any other country are inclined to buy in advance of needs. Wild rumors concerning phantom supplies of great magnitude in Russia have been floating about. Articles featuring great reduction in costs in Kansas, Russia, and elsewhere have been broadcasted. It may be true that a few farmers in western Kansas have materially reduced their costs, particularly in years when it rains, but this area cannot raise enough wheat to feed the world. The writers have seen no evidence of phenomenal exports from Russia nor have they seen evidence of vast new areas that are going to be used for wheat growing in any country . . . ."

"For centuries, wheat has been very stable when compared with the general price level, in spite of the opening of the United States and Canada, and in spite of the grain harvester. It is easy to introduce one or a thousand tractors. It is not so easy to permanently change the relative values of basic farm products . . . . ."

"The writers see no reason for anticipating that the wholesale price of wheat will be out of line with the average of all wholesale prices in the next ten to twenty years . . . . ."

These opinions, coming from such men as Drs. Warren and Pearson are extremely encouraging for the rather distant future. What of the present and the immediate future?

Farm prices of wheat are widely out of line with other prices. They may begin the return to a better relationship soon, but usually recovery is slow. In the wheat market conditions may change very rapidly and an expected large crop may fail to materialize, but these factors are solely in the realm of possibilities. We can get no stability in our agriculture if our only hope of profit is when the world wheat supplies are generally short. There is also the possibility that shortness in our own crop may be the real cause of the increase in world wheat prices.

We have heard many recommendations to change our general farm practices, and go in for "mixed" farming. Livestock sufficient for farm requirements is good practice on most farms at all times. The farmers who make most out of livestock enterprises are those who have stock as a permanent part of their farm businesses, and not the ones who would buy at present high prices to sell later when prices for their output are lowest. Very careful thought should be given, before heavy investments in stock of any kind are made in all sections of Saskatchewan.

Should the acreage of wheat be reduced on our wheat farms? In some sections of Saskatchewan wheat growing can never be really successful at any time. Wheat has been grown because of the lack of other opportunities, and has given some return for the costs incurred. In many sections of Saskatchewan however, wheat growing has been profitable in the past. The farmers who have no alternative better than wheat growing should certainly seed the best land, but might well hesitate to seed wheat where crops are less likely. Unless prospects improve before seeding, 1931, will be a poor year to take chances on anything except the best. Use the farm power and labor that is available, but keep down all expenditures as far as possible. If

horses are available to do the work, it will probably pay most farmers to keep the tractor in the yard for most of the season.

Those who rent land will need to give more than the usual consideration to the terms of leasing. At present prices, the usual shares will be inadequate to return costs to the operator, and the share going to the land owner is hardly large enough to pay taxes. Where new leases are being made, many new complications are involved, and fair returns to all parties are difficult to arrange.

Greater economy is needed in our local governments. Burdens of taxation are far from uniform, and in some marginal areas are speeding up the abandonment of the sections. Changes in sizes of municipal units might well be considered, in view of the modern facilities of transportation and communication. The combination of four municipalities would considerably reduce overhead, and permit greater efficiency and wiser provision of services. We are now expecting more from our local governments than formerly. Studies of rural taxation in all its branches are urgently needed.

Some of the important problems of Saskatchewan agriculture have been presented, and some suggestions of limited scope have been offered. The ultimate solution of these intricate problems for each of our farmers will, of necessity, come from the farmers themselves.

PURITY CONCEPTS WITH RESPECT TO CROP VARIETIES*

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There are various conceptions and misconceptions respecting purity. Purity definitions and standards have long been a problem with agronomists. That which seems pure to one person is considered by another to be of variable type. Purity concepts are of more than academic interest, for they intimately concern the farmer, the plant breeder, the seedsman, the grain merchant and others. It costs money to attain and maintain crop and seed purity. The purity problem, therefore, is particularly important at the present time.

Purity, as applied to crops and crop seeds, is the condition of being free from admixture or foreign material. A more liberal definition involves only freedom from harmful elements. Purity, then, involves freedom or the condition of being free. Most thinking people readily acknowledge that the term free is used almost wholly in a relative manner. *Comparatively free* is meant. It is apparent to those who have seriously considered the matter that the term *pure* is also used relatively.

There are many people who have not given fundamental consideration to the practical or relative meaning of the term *pure* as compared with the theoretical or absolute meaning of this term. Confusion in their interpretation has resulted. Not a few people, in speaking of a seed sample, a variety or a strain, use the word *pure* in an absolute sense. They say *pure* and mean *wholly pure,* not realizing that perfect or absolute purity probably never exists in reality.

A good example of this attitude is the general usage of the term *pure line* or of the word *homozygous.* The reasoning in connection with this usage is as follows. According to mendelian laws of inheritance a normally self-fertilized species gradually becomes homozygous or pure through the simple process of continuous self-fertilization. After about ten generations of self-fertilization in the progeny of a cross between two varieties any selected plant should produce progeny that are practically identical. These progeny can be bulked to form a new variety or strain called a *pure line.* Such is the simple and beautiful conception of the *pure line.* But the beauty of the conception is somewhat marred when, in these so-called *pure lines,* plants arise that are obviously different from the others, or when a farmer makes a head selection from a so-called *pure line* and later finds its progeny do not closely resemble the parental stock.

Since the word *pure* is used relatively it is important to interpret as accurately as possible its proper meaning in connection with any given material. When, for instance, is a wheat variety pure? Early in the 19th Century John Le Couteur, after much work with wheat, grew what he thought was a uniform variety. Professor La Gasca of the University of Madrid, upon inspecting this wheat in the field, pointed out 23 distinct forms (*1*). Un-

*The presidential address delivered before the Western Canadian Society of Agronomy at Winnipeg, Manitoba, on December 29, 1930.
†Professor of Field Husbandry.

doubtedly Le Couteur's variety was far purer in type than the average field of that time. By the end of the 19th Century general conceptions of satisfactory varietal purity were fairly exacting, yet far less critical than those of modern times. Yet even with the precise conceptions of the present day we have in our prominent varieties, Ceres with its variation in spike type, Reward and Garnet with their occasional badly off-type plants, and so on. Certainly these varieties are much purer than they would be if they carried mixtures of other varieties. And what about Marquis? For years complaints about variations in this variety were heard. Finally it was reselected by various individuals and the new strains are found to contain off-types and to differ one from another in various characters.

Turning now to the crops that are frequently or usually cross-fertilized, the term *pure* refers to uniformity within more or less wide limits. When, for example, is a strain of red clover pure? There, cross fertilization is almost entirely obligatory and absolute uniformity is out of the question. In corn there is a close approach to uniformity in lines that have been selfed for ten years or more, but they are not of direct use commercially. In rye the varieties are by no means uniform. In grasses and alfalfa *pure* has a meaning that is far from being absolute. Finally, in a clonally propagated crop such as potatoes, actual germinal homozygosity may be of no practical consequence.

If it may be assumed that it is desirable to have as high a degree of purity in a given crop as is economically feasible, then it immediately becomes necessary to determine or attempt to determine for each crop the factors relating to purity and the importance of those factors. This would take much more time than is at our disposal. It will probably serve our purpose as well to limit the discussion to some commonly grown crop in which problems of purity have been the subject of much argument. I can think of no better example than wheat.

The factors concerned with obtaining or maintaining a high degree of purity in a normally self-fertilized crop such as wheat may be listed as: (a) the rapidity of the theoretical approach to homozygosity through the operation of the laws of heredity, (b) mutation, (c) environmental influences, (d) mixtures, (e) natural crossing, (f) small genetic variation, and (g) the breeder's technique and judgment. Each of these factors should be considered separately, for some are far more important than others.

(a) According to mendelian laws of inheritance, a continuously self-fertilized *population* becomes steadily more homozygous and the proportion of individuals that are homozygous for any number of factor pairs in any given segregating generation is easily found by the formula $(\frac{2^n - 1}{2^n})^m$ in which "n" is the number of segregating generations and "m" is the number of separately inherited allelomorphic pairs. For example, if a cross between two varieties involves ten major factor differences (generally there would be many more than ten) there would be in the tenth segregating generation 99.02 per cent of homozygous types. With a parental variety difference of 20 factor pairs the proportion of homozygous individuals in 10 years would be 98.06 per cent, and in 20 years only 99.98 per cent or about one-fourth as pure as the Canadian Seed Growers' Association's standard for the purity of Elite Stock. Furthermore, the mendelian approach to homozygosity is in reality not the

same as it is in theory, because there are various disturbing factors such as mixture, mutation and natural crossing, which retard the progress of purification, and others like linkage that hasten homozygosity.

If, instead of major differences, the sum total of differences are considered, the difficulty of attaining homozygosity (supposing it to be desirable) would be well nigh insurmountable. It is probable that full a hundred different characters governed by a thousand or more different genetic factors are present in a given population and in any plant taken from it. Belling (*2*) has counted more than 2100 of what appear to be factors or genes in one genus that he is studying.

(b) Little is known about the prevalence of mutation in crop plants, but available evidence indicates that mutations of importance occur relatively infrequently in our common field crops. However, insofar as they do occur, mutations retard the attainment of purity.

(c) Environmental effects often mask small inherited differences and therefore preclude the possibility of attaining uniformity in minor characters. DeLong (*3*) at Lacombe found that under extreme conditions respecting the spacing of plants of Marquis there was much variation in certain spike characters. In an exhaustive study of spike and glume characters of Marquis we found at Saskatoon that fluctuations due to environment were easily confused with small inherited differences.

It is not surprising that environmental effects are often indistinguishable from inherited effects. Numerous studies have shown that the soil varies greatly within areas of a few square yards. Probably no two plants have exactly similar soil conditions for their root systems. Even if they had they could not equally take advantage of these conditions owing to small differences in the position of the seed when sown or to a multitude of small differences in their immediate environment above the surface.

(d) Mixtures constitute a fourth factor concerning purity. Regardless of all one can do, some mixtures are almost certain to occur. Gross mixtures such as those resulting from the use of insufficiently clean wagons, separators, binders, drills, etc., or from careless habits, may be guarded against and (at a cost) made negligible. But it is practically impossible to prevent or even to fully ascertain what mixtures are caused by birds, rodents, melting snows and wind storms.

(e) One very distinct form of mixture deserves special mention and that is natural crossing. In the frequently cross fertilized crops natural crossing is not known as mixture but as an act of nature. In the self-fertilized crops, however, such unsystematic behavior on the part of Nature is severely frowned upon. This is especially true where wheat is concerned. In an extensive study of natural crossing during the past five years at Saskatoon* various combinations of wheat varieties were used and the amount of natural crossing was found to vary from zero to nearly 10 per cent. In other places as much as 30 per cent has been reported. Natural crossing is more frequent when the different plants are growing close together. Henry (*4*) found in flax that the amount of natural crossing between two varieties dropped rapidly when the varieties were grown farther apart. When an off-type plant or a plant

*Unpublished results obtained by the writer.

of another variety grows in a field of, say, Marquis there is an excellent chance that some of the pollen from this plant will fertilize florets of the surrounding Marquis.

(f) Small genetic differences as a factor opposed to the obtainment of a high degree of purity are linked up intimately with the operation of the environment. Small morphologic or physiologic characters are undoubtedly just as truly inherited as large ones. The chief difference from a purity standpoint between a small genetic difference and a large one is that the former is difficult and often impossible to recognize in any particular case, whereas the latter is usually quite obvious in spite of environmental effects. Extensive studies made by the writer (*5*) on Marquis strains have shown definitely with respect to such characters as spike density that environmental effects obscured strongly the small genetic differences that were known to be present.

(g) Finally we come to the last and most significant factor: the plant breeder's technic and judgment. There comes a stage in the evolution or progress of any crop breeding project, for example a cross in wheat, when the breeder decides that one or more of his lines is *sufficiently* pure to be *considered* uniform and thereafter harvested and propagated as a homogeneous population instead of being selected further on a single plant basis. Whether or not a given line is highly pure or only moderately pure for several or for many characters depends largely upon the breeder's technique.

What are the breeder's methods and why is his judgment so vital in the matter of purity? We can answer these questions best by following him through a representative breeding project. Since nearly all new varieties result directly or indirectly from hybridization, we may take for an example a cross, say between two bread wheat varieties differing in many characters including height, earliness, stem rust resistance, grain yield and baking quality. Let us suppose for the sake of simplicity that these varieties are very nearly pure for all characters. The F_2 or first segregating generation is very heterozygous, showing all sorts of combinations of the characters of the parent varieties. F_2 plants of desirable appearance are selected and progeny of each is grown in a small plot. Selection is practised similarly in the F_3 and F_4 generations and frequently again in F_5.

In F_5 or F_6 a number of lines are sufficiently uniform for bulking. That is, no longer will one or more single plants be selected from this line to be carried along as separate entities or new lines in F_6. Instead of that, all of the plants will be bulked and the line handled in the same way as a variety by considering all plants to be closely alike. On what basis does the plant breeder take this important step? His decision rests upon the *apparent* uniformity of the plants in the small plot before him. Usually there are from 20 to 100 plants in such a progeny plot from a single plant selection made the previous year. The seeds sown in this plot were presumably about equally plump, equally vigorous and had an equal start. That this in reality is not true is evidenced by the fact that they do not emerge from the soil the same day. Presumably all the plants have the same opportunity for growth. This is perhaps never the case owing to soil variability, insect damage, disease and unequal space utilization both above and below the soil surface. Complete

uniformity, therefore, could not be expected in fully homozygous material and certainly is never obtained in any material grown. Thus no exact measure of uniformity in plant material is available and the breeder of necessity must employ approximate measure. Plots of the parent varieties are the logical check material to use.

We have progressed to the use of one or both of the parent varieties as a standard whereby to measure the uniformity of a hybrid line. How shall such a standard be used? How many characters shall be considered? Germination of the seed and emergence from the soil might be used but in practice are found to be of little value. Uniformity of heading is generally thought important. To ascertain this accurately requires recording of the day of the full emergence of the earliest spike on every plant in a given line and a comparison of this data with similarly taken data from the nearest plots of the parent varieties. The hybrid line is considered uniform for heading if the data show a normal frequency curve and the range is within some arbitrary percentage, say 10 per cent, of the average range of the parent variety plots. Rarely however, is such a biometrical calculation made in connection with uniformity of heading. Seldom is there detailed data taken on the exact day of heading of each plant of each plot of each hybrid. It would require large funds to furnish such data. Undoubtedly the money would be better spent otherwise, since even detailed data would not guarantee a line's uniformity or non-uniformity. No, the breeder is not positive, but he feels reasonably sure that the line is or is not under the very limited circumstances of the test, approximately as uniform in heading as the nearest plot of one or both parent varieties. And that is all he *is* sure of.

Another character of value is straw strength. Could anybody exactly ascertain a line's uniformity for this character? He could not. But the breeder by observation obtains a fairly accurate estimate of the uniformity of his lines under the conditions of the test. Height of plant is also important. In this case exact heights can be taken and comparisons made biometrically. Most breeders would make very little progress if they had to have many thousands of plants measured for height and several hundred variability coefficients calculated in order to classify his lines for uniformity of height. Again it is a matter of the breeder's judgment. Then there are such characters as disease resistance, ripening and resistance to shattering. Uniformity here is an approximate matter at its best.

We have seen how the judgment of the plant breeder, usually from visual inspection of the growing plot in comparison with mental images of plots of the parent varieties, is the final and almost exclusive criterion of the uniformity of a given line for any of the large field characters. Turning then to spike and seed characters we find again that it is the judgment of the breeder which results in a line being called uniform. No proof of uniformity exists and no matter how expert the breeder may be, he cannot possibly distinguish between small inherited differences and differences caused by environmental influences.

Now we come to two very important characters in wheat, namely yield and baking quality. How does one know when a line is uniform for these characters? One doesn't. And yet these characters are of the highest im-

portance. Take the breeder standing before a plot containing any one of the hybrid lines. Some plants will obviously yield more than others. But the apparent yielding capacity as shown by the size, vigor, stooling, etc. of the plant has been shown again and again to be a very unreliable index of inherited yeilding ability. This being the case, it is obvious that uniformity of yielding capacity will not be ascertainable with any degree of certainty. Neither can uniformity of kernel plumpness or of kernel texture be determined with any exactitude.

As for baking quality, the plant breeder has for years hoped that the cereal chemists would perfect some test whereby an accurate indication of baking quality could be obtained from a few grams of seed. Such a test is still not available. Much less is there a test usable on individual plants.

We have considered the fact that the best of our existing varieties are neither homozygous, pure nor uniform, but that compared to most of the old varieties they are *relatively pure*. We have discussed the factors concerned with this situation and can now deal with *purity* as a practical consideration. This involves two main points: (a) the possibilities of a closer approach to uniformity or purity in new varieties or in reselected existing varieties, and (b) the feasibility of attaining any possible greater measure of purity.

As to the first point, it is undoubtedly possible to attain greater purity both with respect to mixture and to genetic constitution. Mixtures can be avoided to a large extent through precautionary measures. Natural crossing and its effects can be eliminated fairly well and somewhat more uniformity can be obtained as far as the more easily observed characters are concerned. This is being done at Saskatoon, Ottawa and elsewhere by means of very painstaking methods. Lack of refinement in testing methods prevents homozygosity for factors governing milling and baking qualities, seed plumpness, seed shape and similar characters. How far will it be economically feasible for the plant breeder, the farmer, the seedsman or any other interested party to work toward a close approach to uniformity? Much may be possible to do with great effort and cost. Little of this may be really worth while. It is a question whether the results of the present highly specialized methods of purifying Marquis strains from morphological off-types will fully justify the expense involved. And even these methods could be much improved upon, for they hardly touch upon physiological characters. It is probably safe to predict that further approach to uniformity may be expected in new varieties only insofar as new methods of attainment prove to be sufficiently rapid and inexpensive to justify their use.

The attainment of greater purity will be looked upon differently by different people. The farmer will not be interested in a very high degree of uniformity, especially if it involves greater expense to him. He wants practical purity, which means freedom from detrimental admixture and reasonable uniformity for important characters. The breeder's viewpoint is about the same, excepting that he will be interested in fair uniformity for disease reaction and some other characters not readily observed in the field. The seedsman favors uniformity insofar as it represents greater value and attractiveness to the buyer, but he would probably frown upon an added amount of uniformity if it increased the cost of seed without demonstrating superior

value. The average government official feels that purity standards should be practical. If increased uniformity could be shown to represent greater intrinsic value he would favor it. The Canadian Seed Growers' Association has very high standards especially with regard to purity and uniformity for important outward morphologic characters. On the whole the farmer, plant breeder, seedsman and government inspector seem to agree that these standards are satisfactory; but it must always be remembered that the reason why they are considered satisfactory is that they are interpreted in a practical manner. The expression 99.99% pure means very little of itself, but in practice it is meant to mean and actually does represent a high degree of purity and uniformity.

In conclusion let us recapitulate the main points. Purity is the state of being pure. Absolute purity is unknown, and most people use the word *pure* in a relative manner. Purity concepts have changed with the years and vary markedly with different crops and different people. Purity standards have been raised very high in self fertilized grain crops, particularly in wheat. The attainment of a very close approach to absolute purity is prevented by various factors including admixture, mutation, environmental effects, natural crossing, small genetic variations, limitations in the breeder's technique and even by the operation of inheritance laws. Undoubtedly greater purity and uniformity than we now have can be obtained. The question is, how much purity is really needed? Farmers, plant breeders and most other interested parties agree that they want practical purity, that is, freedom from detrimental admixture and reasonable uniformity for important characters.

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FURTHER STUDIES ON THE HARD SEED PROBLEM: ALFALFA AND SWEET CLOVER.

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The work reported in this paper is a continuation of work previously reported with full details of the methods of experiment and interpretation used (*1, 2, 3* and *4*) and has been conducted in exactly the same manner so that no recapitulation of methods will be made here.

Since the last of the papers mentioned was published, a paper by Whitcomb (*5*) has come to hand in which that author used the statistical method in studying the behaviour of samples of alfalfa, sweet clover and red clover containing varying percentages of hard seeds. With regard to alfalfa his findings corroborate those of the present writer. Referring to sweet clover, Whitcomb states, "This ..... indicates a low value for hard seeds of sweet clover", but does not specify in what proportion they may be expected to contribute to the stand. His results are taken for a period of 75 days after seeding. At a corresponding period the relative value of the hard seed of sweet clover reported in (*1*) varied from 32 per cent to 78 per cent, averaging about 50 per cent, compared with 100 per cent for that of permeable seed; these results however were on the basis of only one year's work, and were obtained during a season which appeared particularly favourable to the germination of hard seeds. He reports further that hard seeds of red clover were intermediate in value between those of sweet clover and alfalfa.

Before proceeding further I wish to make an observation with regard to the method of weighting used in the equation method for determining the hard seed value in papers (*1*) and (*4*). In reviewing that work I have come to the conclusion that there was not full justification for assigning any other than unit weight to any of the observations but at the same time I wish to point out that this does not affect the conclusions in any degree and affects the actual figures reported only slightly.

I. The Comparative Value of Scarified and Unscarified Alfalfa Seed

Two samples, A (scarified) and B (unscarified) were planted at Lacombe and Brooks in 1927. Results obtained during the first year have already been reported (*2*). In 1928 the plots were harvested at Brooks and the yields determined. These are given in table 1.

As in 1927, there is again a slight difference in favour of the scarified seed, to the extent of 3.3 per cent of the yield of the scarified sample. In view of the fact that the latter had 27 per cent fewer hard seeds this difference cannot be considered as significant with respect to the degree of scarification of these samples.

This corresponds with the results previously found and concludes the work it is proposed to do on the value of hard seeds of alfalfa.

*Supervising Analyst.

TABLE 1.—*Yields (green weight) from scarified and unscarified alfalfa seed compared. 1928*

	Scarified (A)		Unscarified (B)	
	Plot No.	Lbs. per acre	Plot No.	Lbs. per acre
First cut.	A 1	19515	B 1	17680
	A 2	16983	B 2	17076
	A 3	18030	B 3	17940
	A 4	19250	B 4	17940
		Avge. 18445		17659
Second cut.	A 1	11218	B 1	10348
	A 2	11000	B 2	10238
	A 3	11545	B 3	11545
	A 4	9367	B 4	10348
		Avge. 10783		10620
		Total Avge. 29228		28279

The laboratory test on these amples gave:—

Sample	Germ. %	Hard seeds %
A	86	10
B	59	37

TABLE 2.—*Yields (green weight) from scarified and unscarified seed compared (Sweet clover seeded 1928).*

Lacombe (Cut July 12th, 1929).

	Scarified (C)		Unscarified (B)	
	Plot No.	Lbs. per acre	Plot No.	Lbs. per acre
	C 1	10700	B 1	16300
	C 2	25800	B 2	14900

Plot C 2 showed 5% and B 2, 25% winter killing.

Brooks.

	Scarified (A)			
First cut. 1929	A 1	19385	B 1	29620
	A 2	19600	B 2	30930
	A 3	16773	B 3	27445
	A 4	14810	B 4	30930
		Avge. 17642		29731
Second cut 1929	A 1	12853	B 1	13073
	A 2	11327	B 2	12198
	A 3	13073	B 3	7624
	A 4	15900	B 4	16337
		Avge. 13288		12308
		Total Avge. 30930		42039

Laboratory tests on these samples gave:—

Sample	Germ. %	Hard seeds %
A	93	5
B	59	35
C	93	6

II. The Comparative Value of Scarified and Unscarified Sweet Clover Seed.

In this section are reported some additional yields taken in 1929 from the plots seeded in 1928 on which a report for that year has already been published (*3*). They are given in table 2.

These results agree in general with those found for the yields taken in 1928 from the same plots. As it was not feasible to secure for this seeding sufficient unscarified seed to prepare a scarified sample from it and for the two samples thus to be strictly comparable as to strain, it is at least possible that the higher yields given by the unscarified seed may be due to inherent differences in yielding power of the two samples. The same criticism applies to the samples used for the 1929 seeding next to be reported. In the yield plots seeded in 1930 it has been possible to use the same seed throughout.

Yield Plots 1929

In 1929 plots were again sown at Lacombe and Brooks to two samples, one scarified and one unscarified. Table 3 gives details of the samples used.

Table 3.—*Details of samples of Sweet Clover (M. alba) seeded at Lacombe and Brooks for yield tests in 1929.*

Sample	Germ. 5 day %	Hard Seeds %	
A	75	15	remainder:—broken sprouts, weak sprouts and dead seed.
B	8	83	

As before, the plots at Lacombe were seeded broadcast but at the rate of 20 lbs. per acre, while those at Brooks were drilled in at the rate of 6 lbs. per acre.

Lacombe. Two 1/100 acre plots were seeded to A sample and two similar plots to B sample on June 3rd. These plots were designated A 1 and A 2, B 1 and B 2 respectively. On July 24th and again on Aug. 20th stand counts to determine the number of plants per square yard were made. The data obtained are given in table 4.

Table 4.—*Plants per square yard.*

Plot No.	No. Plants per square yard. *Area:— a	b	c	d	Avge. per square yd. each plot	Avge. for combined plots
					(1) Count July 24th, 1929.	
A 1	471	199	159	139	242.0	
A 2	208	234	171	245	214.5	228
B 1	75	104	60	179	104.5	
B 2	141	74	93	82	97.5	101
					(2) Count August 20th, 1929.	
A 1	3 3	229	181	166	234.8	
A 2	227	225	217	132	200.2	218
B 1	50	53	129	206	109.5	
B 2	140	97	109	99	111.3	110

*a, b, c, d refer to any areas of 1 sq. yd. selected at random.

The figures in the final column may be analysed by a modification of the equation method in such a way as to determine the relative values of the hard and permeable components, though not their actual field germination†. This analysis is given in table 5.

TABLE 5.—*Relative value of hard and permeable components.*

Date of count	Rel. value H. S. where P. S. = 100
July 24th	27.2
Aug. 20th	38.4

No yields were taken from these plots in 1929.

Brooks. Four plots 8′ × 15′ (after perimeter deducted) were sown to A sample (scarified) and four similar ones to B (unscarified). Seeding was at the rate of 6 lbs. per acre, drilled in rows.

On June 27th and on July 17th stand counts were made to determine the number of plants per linear yard.

The results are given in table 6.

TABLE 6.—*Plants per linear yard.*

Plot No.	*Row:—	a	b	c	d	e	Avge. per yd. each plot	Average all plots
							(1) Count June 27th, 1929.	
A 1		27	19	20	31	25	24.4	
A 2		22	17	25	20	17	20.2	27
A 3		33	20	23	25	43	28.8	
A 4		33	29	47	29	36	34.8	
B 1		16	23	15	14	13	16.2	
B 2		20	11	12	17	11	14.2	16
B 3		14	13	11.	12	15	13.0	
B 4		22	22	23	20	13	20.0	
							(2) Count July 17th, 1929.	
A 1		31	26	26	29	27	27.8	
A 2		28	32	25	22	21	25.6	29
A 3		43	24	32	20	38	31.4	
A 4		23	47	26	39	25	32.0	
B 1		18	21	19	19	18	19.0	
B 2		18	14	17	16	17	16.4	18
B 3		18	22	9	13	34	19.2	
B 4		19	18	14	10	16	15.4	

* Rows a, b, c, etc. refer to any rows selected at random.

† We have two unknowns, the field germination of the hard seeds and that of the permeable. Let these be x and y percent respectively.

Now if the sample contains q% of hard seeds and r% of permeable, the actual percent field germination of the sample is represented by $\frac{xq}{100} + \frac{yr.}{100}$ We do not know the *per cent* field germination however but only a figure V to which the hard and permeable seeds have contributed in proportion to their respective field germinations.

Let F be a factor such that $V F$ equals the total field germination, expressed as percent, of the sample seeded. We may now put

$$\frac{xq}{100} + \frac{yr}{100} = VF$$

and determine x and y in terms of F, by solving the simultaneous equation obtained from this general form by substituting the appropriate data for samples A and B. In our determination of the ratio x/y, F cancels out. Thus we cannot with these data determine the actual values of x and y but we can determine the ratio between them.

Applying the equation method to the results in this table as has been done for table 4 in order to determine the relative value of the hard seeds we have:—

TABLE 7. —*Relative value of hard and permeable seed components for the 1929 seeding at Brooks.*

Date of count	Rel. value of H. S. where P. S. = 100
June 27, 1929	40.4
July 17, 1929	41.0

These plots were harvested on September 12, 1929, the yields secured being shown in table 8.

TABLE 8.—*Yields (green weight) compared (1929 seeding at Brooks).*

Scarified		Unscarified	
Plot No.	Lbs. per acre	Plot No.	Lbs. per acre
A 1	13690	B 1	14700
A 2	10460	B 2	12060
A 3	9965	B 3	13430
A 4	10528	B 4	10302
Average	11161		12623

The odds in favour of this difference of 1462 lbs. per acre being significant are 25 :1, which indicates a fairly high degree of probabilitiy; but we may compare this lower yield of the scarified seed plots with the lower yield given in table 1 for plots A 2. and B 2. which were reported (*3*) to have been seeded too thickly. It appears that the heavy seeding in that case may have resulted in a somewhat lower yield due to relative crowding of the plants and in the plots under discussion the lower yield was in the scarified seed plots where the stand was heavier (table 6). It is not certain however that the higher yield from the unscarified seed was worth more than the lower yield from the scarified seed, since it was the result of a ranker growth, (see Plate II.) which may not have produced fodder of as good a texture or as palatable as that of the scarified seed plot.

The results presented in this section are taken up in the discussion at the end of the paper.

TABLE 9.—*Details of samples used in 1929 field germination investigation (Sweet clover, M. alba).*

	Laboratory test: count after 5 days		
Sample No.	Germ.	Hard seeds	Total germ. as entered on laboratory report
1	76	2	78
2	77	14	91
3	60	24	84
4	51	35	86
5	53	41	94
6	35	62	97
7	31	68	99
8	22	78	100

(Remainder, weak and broken sprouts and dead seed.)

III. Field Germination of Hard and Permeable Sweet Clover Seed

Plots were again seeded at Lacombe and Brooks, following exactly the same procedure as that outlined in (*1*). Eight samples with varying percentages of hard seeds were used. Details of these samples are given in table 9.

The weather proved very unfortunate for these plots at Lacombe since shortly after the first count was made on the last seeding a heavy windstorm blew about one inch of soil off the plots, with the seeds and some of the seedlings. It was not feasible to reseed the plots, but some results were secured which have a limited value.

Table 10 gives the data obtained together with dates of seeding and counting, and analysis of results by the equation method.

Table 10.—*Field results 1929 and analysis.*

	LACOMBE				BROOKS			
Inv. No.	1. Seeded May 1st, 1929 Counts:— May 20	June 11	2. Seeded May 21st, 1929 June 11	3. Seeded June 10th, 1929 July 2	Plot seeded May 8th, 1929 Counts:— June 5	June 26	July 16	Aug. 7 Aug. 22 Sept. 13
1	24	27	32	43	35	35	35	35
2	28	53	28	45	47	48	49	49
3	14	50	32	36	28	30	31	32
4	7	35	36	44	39	42	43	43
5	13	34	25	41	40	42	45	45
6	7	21	17	35	28	31	31	32
7	8	17	19	26	26	27	27	28
8	4	11	10	8	15	17	17	18

Analysis of results by the equation method.

	LACOMBE				BROOKS			
Plot No.	Count No.	Field germ: Hard Seeds	Field germ: Perm: seeds	Rel. value H.S. where P.S. = 100	Count No.	Field germ: Hard seeds	Field germ: Perm: seeds	Rel. value H.S. where P.S. = 100
1	1	...	30.6	...	1	12.7	53.8	23.6
	2.	2.1	59.7	3.6	2	15.2	55.2	27.6
2	1	5.8	44.2	13.1	3	15.5	56.4	27.5
3	1	8.6	61.7	13.9	4, 5, 6	16.7	56.4	29.6

In studying these figures and comparing them with the similar analysis on sweet clover reported previously (*1*, table 11) it is seen that the same general tendency is evident, namely a higher relative value for the hard seeds with a later date of seeding at Lacombe. It was pointed out in that paper that the season of 1927 appeared particularly favourable to the germination of hard seeds. This is borne out by the much higher relative value found for hard seeds in 1927 than in 1929.

At Brooks the relative value for hard seeds in 1929 was about 20 per cent lower than in 1927, but in general the behaviour of the two components parallels that found in 1927 quite closely.

Rainfall at this station was very scanty from May to August, a total of only 3.18 inches falling during those four months. This rainfall was supplemented by two four inch irrigations making the total moisture received 11.18 inches.

Winter Mortality

In the spring of 1930 a check was made on the Brooks plot, following previous practise, to determine the plants which had survived the winter and the additional germination.

Table 11 shows the standing of the plots at the final check 1929, and in the spring 1930, not including additional germination; also analysis by the equation method is given.

TABLE 11.—*Standing of plot (Brooks) in the fall 1929 and in spring 1930 (percent) and analysis.*

Plants present			Analysis by equation method		
Sample No.	*Fall*	*Spring*		*Fall* %	*Spring* %
1	29	27			
2	40	37	Contributory H.S.	16.5	11.0
3	27	22	Field Germ: P.S.	46.6	42.5
4	38	30			
5	39	35	Relative value		
6	28	26	H.S. where	35.6	25.9
7	24	18	P.S. = 100		
8	17	12			

The middle column of the left half of this table cannot be compared directly with the last column of the Brooks plot, table 10, since in that table is included all the germination that had occurred up to the time of the final count, whereas table 11 includes only those plants which were still alive at that date.

In the right half of the table is the analysis of these figures which shows the degree to which each component, hard seed and permeable seed, has contributed to the stand at the given count. There has been some loss due to winter killing but the loss is relatively greater among the plants which derive from hard seeds than among those from permeable seeds. This agrees in general with the greater winter hardiness of plants produced by permeable seeds reported in (*4*) for sweet clover and is the reverse of that which was found for alfalfa.

Additional Germination After the Winter

On June 5th, 1930, a count was made to determine the germination of seeds that had wintered over. The results, given in table 12, were analysed to determine the relative contribution of the two components, realizing, of course, that the permeable seeds would not be expected to contribute at all. The analysis was made partly as a further test of the applicability of the method and is in accordance with theoretical expectation. (For the significance of the negative value reported for the permeable seeds see discussion p. 685 of (*4*)).

TABLE 12.—*Percent germination of seeds wintering over and analysis.*

Sample No.	Brooks Plot	Analysis		
1	1			
2	3			
3	2		Hard Seeds	No counts on the Lacombe plots, which were destroyed by wind.
4	2	Contributory	18.6	
5	7	Field Germ:	Perm. Seeds	
6	13	percent	0.9	
7	17			
8	11			

Comparing this with the results previously reported in (*4*) it is to be noted that in the season of 1927-28 the Brooks plot did not show any additional germination in the spring of 1928 whereas additional germination in 1930 was considerable. This accords with the statement in that paper that the growing season of 1927 appeared to be particularly favourable to the germination of hard seeds.

Total Plants Surviving at End of Experimental Period. (Late Spring 1930)

Various factors contributed to mortality but the standing of the plot at the period at present under discussion may be considered as representing the final stage so far as the crop of the second growing season is concerned. This is given in table 13 together with the analysis.

TABLE 13.—*Standing of plot in late spring 1930 and analysis.*

Sample No.	Brooks Plot	Analysis	
	Plants Present		
1	28		
2	40		Hard Seeds
3	24	Contributory	29.5
4	33	Field germ:	Perm: Seeds
5	42	percent	41.9
6	39		
7	35	Relative value H.S. where P.S. = 100	
8	23	74.4%	

DISCUSSION

The object of these investigations has been to determine, if possible, the proportion of hard seeds which should be included in a laboratory germination report as being of value for seeding purposes. This involves many considerations, not only whether the hard seeds will germinate in the field but also to what extent and when; whether there is any difference between plants deriving from such seeds and from the readily permeable seeds and, further, the relative value for fodder purposes of crops from seed having a high proportion of hard seeds. Some of these considerations are, strictly, beyond the scope of the seed analyst and any conclusions which he draws must necessarily be presented tentatively and with some diffidence.

This work has been divided into two series of studies. In the one, the attempt has been made to follow the behaviour of the two components, hard and permeable, in the field and since it is impossible to do this directly for reasons already fully discussed, it has been necessary to do so indirectly

by a mathematical method which appears to have been justified in use. In the other a direct comparison has been made between scarified and unscarified seed for the purpose of checking the results of the former and for the sake of any different aspects of the problem that such a study might reveal. There has however been some interlapping in the two series.

The two seasons' work so far conducted with *Melilotus alba* have not been entirely satisfactory on account of cutworm and adverse weather conditions and a further season is being given to work with this species, but it might be well to summarize here the results so far obtained.

During the season of 1927, which has been noted as apparently rather favourable to the field germination of hard seeds, the average relative contribution of the hard seeds to the stand in terms of that of the permeable was 56 per cent (*4*). Since sweet clover is grown largely as a two-year crop the stand entering the second growing season should also be taken into consideration. In the present case it was shown that the relative contribution of the hard seeds to the stand in the late spring of 1928 was 101 per cent, due almost entirely to additional germination contributed exclusively, of course, by the hard seed component. The corresponding figures for the work reported in the present paper are 30 per cent and 70 per cent.

The yield plots seeded in 1929 (reported in Section 2 of this paper) showed a relative value for the hard seeds of approximately 40 per cent during the first growing season both at Lacombe and Brooks. In the corresponding plots seeded in 1928 it was found that at Lacombe the value was approximately 50 per cent and at Brooks 100 per cent. It seems that under the most favourable conditions, germination of the hard seeds is fairly complete, but our results have indicated 40-50 per cent as the most general value.

With regard to yields, these have in general been higher from the unscarified than from the scarified seed. In some cases this may have been due to inherent differences in yielding power of the samples used, in others it appears to have been due rather to a coarser type of growth resulting from a somewhat thinner stand.

Another point which should not be overlooked is the desirability of prompt and uniform germination for the purpose of controlling weeds. That the practice of scarification helps to provide this there is no doubt.

It is a difficult matter to balance these various considerations in trying to decide on a suitable figure for general use. It seems inadvisable to stress too much the higher yields usually obtained with the unscarified seed, on account of their rather coarse nature. The germination of the hard seeds which have wintered over is, however, an advantage in thickening the stand for the second season but this is to some extent counterbalanced by the less even germination during the first season. On the whole the writer is of the opinion that, as far as it is possible to judge by the work to date, 50 per cent of the hard seeds as shown by the laboratory germination tests would be a fair allowance in the case of sweet clover (*M. alba*) in computing the figure expressing germination value.

Summary

The work reported in this paper is a continuation of studies on the hard seed problem which have been previously reported.

The first section dealing with alfalfa concludes the work on this crop, and confirms results previously obtained, namely, that in alfalfa the hard seeds may be considered as of equal value to the permeable seeds.

The remainder of the paper deals with sweet clover (*M. alba*). Figures are calculated for the relative value of hard seeds expressed as a percentage of the value of permeable seeds, at different intervals from seeding and under various conditions. These are brought together in the discussion immediately preceding this summary.

The greater yields which were usually secured from the use of unscarified seed as compared with scarified are not considered as necessarily significant with respect to hard-seededness.

Hard seeds produced plants which were slightly less winter-hardy than those produced by permeable. This accords with previous findings on this point for this species.

50 per cent of the hard seeds is the figure tentatively suggested for use in computing the germination value of a sample of *Melilotus alba* seed on the basis of a laboratory test.

Acknowledgement

Once again I have great pleasure in expressing sincere thanks to the officials of the Dominion Experiment Station, Lacombe, and the Dominion Irrigation Experiment Station, Brooks, for their coöperation and interest.

Acknowledgement is also due to Mr. B. Forward, Senior Analyst*, at the Calgary Laboratory, who has conducted most of the field work reported in this paper.

*Now Supervising Analyst.

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PROCEEDINGS OF THE FOURTH ANNUAL MEETING OF THE WESTERN CANADA SOCIETY OF ANIMAL PRODUCTION.*

The fourth annual meeting of the Western Canada Society of Animal Production was held at Lethbridge, Alberta, on June 6th and 7th, 1930. In addition to several resolutions of courtesy to those who aided in making the meeting a success, the following general resolutions were passed:

1. *Resolved*: That this annual meeting of the Western Canada Society of Animal Production record its appreciation of the sterling character of the late Dean W. J. Rutherford; of his many years of devotion in the interests of better livestock production in Canada; of the loss which has been suffered by agriculture generally in his passing, and that a copy of this resolution be forwarded to President Walter Murray of the University of Saskatchewan, accompanied by a letter requesting him to convey to Mrs. Rutherford and family the above sentiments and the sympathy of the members of the Society.

4. *Resolved*: That the President appoint a special committee of three to confer with the respective secretaries of the Pure Bred Horse Associations, the Provincial Live Stock Commissioners, and with the Bureau of Agricultural Economics, in an effort to provide reliable data on such matters as the cost of producing a foal and growing it to marketable age, the cost of maintaining horses as farm power; comparative power costs, and such other material as may be necessary in stating the position of the horse as compared to the truck and tractor, and that the possibility of gathering valuable data as above by means of a comprehensive Farm Horse Survey be given careful consideration.

5. Whereas the average beef consumer today is demanding cuts from the light well, but not over finished animal;

   And whereas this definite trend seems to make necessray careful consideration and, inevitably, considerable reorganization in the business of breeding and feeding beef animals with a view to producing at the least possible cost the finished article in best demand by the consumer;
   And whereas the show ring is a necessary medium in any educational reorganization on above lines;

   And whereas, it has very often been claimed that present show ring standards for fat cattle do not appear to assist in the development of what might be termed the "utility" beef animal;

   Therefore be it resolved, that a committee be appointed to carefully survey the entire situatoin in beef cattle production with a view to bringing in recommendations to the next annual meeting of this Society, and further, that the Eastern Canada Society of Animal Production be forwarded a copy of this resolution with the request that it be considered by them, with a view to ultimately arriving at conclusions which would be national in scope.

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*This abstract has been prepared by the Managing Editor from the complete report of the proceedings submitted by E. Van Nice, Secretary-Treasurer. The President's address is given in full. Some papers and reports have been reduced to save space, but may be secured from E. Van Nice, Dominion Experimental Station, Scott, Saskatchewan.

6. In view of the increasing demands for chemical analysis of our feeding stuffs, pastures and range soils, and the increasing importance of the study of mineral deficiencies in our pastures in their relationship to the livestock industry, and since the lack of facilities for analytical work is retarding such mineral studies, *Be it resolved*: that this Society appoint a committee to study the question of establishing a laboratory for such work in Western Canada and report to the Society in 1931 and that a copy of this resolution be forwarded to Dr. J. H. Grisdale, Deputy Minister of Agriculture.
7. Whereas it would appear advisable to coördinate the work now being done by this Society and the Eastern Society of Animal Production, by the organization of a central body;

   Therefore be it resolved:that steps be taken to organize a Canadian Society of Animal Production with eastern and western sections and that the Secretary take up the preliminary arrangements with the officers of the Eastern Society.

   All resolutions passed.

The following officers were elected for the ensuing year:

Honorary Presidents:—Hon. George Hoadley, Hon. W. C. Buckle, Hon. Albert Prefontaine.

Honorary Vice-Presidents:—Dr. R. C. Wallace, Dr. W. C. Murray, Dr. James McLean.

The President, Vice-President and Secretary-Treasurer were elected by ballot according to the constitution as follows:—

President—Dean Shaw, University of Saskatchewan.

Vice-President—F. H. Reed, Lacombe, Alta.

Secretary-Treasurer—E. Van Nice, Scott, Sask.

President's Address

A. M. Shaw*

Professor of Animal Husbandry, University of Saskatchewan.

Before entering upon the subject of my address, which I may say will be brief, I wish to state that it is very gratifying to note that our Society is growing. In 1928, it was decided to admit the poultry husbandmen; last year, they had not yet come in, but we are glad to be able to say that they are out this year in force and are contributing some very valuable material to our program. Right here, I would like to state that in many ways the poultrymen have made greater advances in their chosen field than those of us who have been devoting our time to investigational work with the larger farm animals. I wish also to thank all of the members of the Executive for their support and especially our Secretary who has devoted a great deal of his time to the work of the Society and who is responsible in a large measure for the arrangement of the program itself.

There are, no doubt, many kinds of research work that might be dealt with in an address of this kind, but with your permission, I will confine my remarks to one or two phases of the livestock industry. Before discussing the livestock, however, let me say a word about agriculture in general.

*Now Dean of the Faculty of Agriculture.

In the year 1920, Canada exported grain to the value of approximately $220,000,000.00. The same year, the value of her exports of animal products amounted to $145,000,000.00 in round numbers. By 1929, the value of her grain exports had increased to nearly $500,000,000.00, while her exports of animal products had almost disappeared. That is, the trend during the past decade has been toward the increased production of grain and away from the production of livestock and livestock products. In other words, Canada is apparently endeavoring to put all of her export eggs in one basket. There probably are many very good reasons why these conditions have arisen, but nevertheless a development of this kind tends to create difficulties and sooner or later, inevitably results in disaster.

Some diversification of effort along the lines of production must be resorted to by the farmers, particularly the farmers of western Canada in order to balance their business and increase their sources of revenue. In my opinion, the time is ripe for diversification and I am speaking now more particularly of Western Canada. This, of course, will mean the keeping of more livestock of all kinds upon the farms.

What breeds of livestock are the most suitable for Western Canada? This is a question that you all have been asked on many occasions. It is not an easy question to answer, and yet we in Canada have allowed importers, breeders, dealers and enthusiastic promoters of all sorts of breeds to answer it to their own satisfaction and profit. The result has been that we find nearly all the types and breeds of farm animals mixed promiscuously throughout the provinces of Canada without any very serious effort being made by anyone to find out whether certain breeds are more suitable than others or not.

The question of environmental conditions is of fundamental importance as is also the system under which the animals are to be kept. In connection with the first, I would like to draw your attention to the fact that the environmental conditions on the farms of the prairie provinces are very similar all the way from Winnipeg to the foothills of the Rocky Mountains and from the International boundary to the northernmost settlements.

During the past year, I had the privilege of visiting Britain and, while there, made a study of this very question. There the class of livestock kept is largely governed by the environmental conditions. For instance, the British farmers' ewe flocks are very frequently made up of hardy, native types that apparently are much better able to live and thrive under conditions that obtain on the average farm than are the more artificial kinds. They prefer a hardy, medium-sized, natural type of ewe with a fleece that adequately protects her from the weather conditions that prevail in the district in which she must live. In fact, the British sheep farmers pay very much less attention to the character and quality of the wool from a market standpoint than we do, but value the fleece according to its usefulness in furnishing adequate protection for the ewe and her lamb. This accounts in a measure for the variety of fleeces one finds among the various breeds kept in the different localities in the British Isles where the differences of soil and climate are much more marked than in Western Canada, some of them possessing fleeces of comparatively low commercial value, but admirably suited for protective

purposes. Examples of that may be found in some of the moorland and mountain breeds. The same holds true with regard to practically all of the other kinds of livestock. Their breeds are many, but one finds that, as a general thing, they possess certain qualifications that fit them to live under the conditions that obtain in that particular district.

There are men in Canada who profess to be able to select certain breeds of farm animals and arbitrarily classify them as preferred breeds; in fact, we have all sanctioned these arbitrary classifications at most of our Western Canadian exhibitions without, for the most part, any authentic data to back up our decision.

Too little attention has been given to this question. To my mind, the fact that the suitability of farm animals to their environment has been largely overlooked in Canada accounts in a large measure for much of our difficulties in connection with uniform production. Simply because certain breeds of livestock are eminently satisfactory when raised in parts of England or Scotland or Holland or some other country, it does not necessarily follow that they will be equally satisfactory in the hands of Western Canadian farmers. As time goes on, it is becoming more apparent that certain types are decidedly better suited than others. An outstanding example of it is to be found in the fine wool sheep that owe their existence to their inherent, or their natural ability to live and thrive under certain conditions; namely, those that obtain on the great plains area of the North American continent. They are hardy, active and vigorous, lacking somewhat in mutton conformation, a trifle superior in weight, quality and value to any of the British breeds. During the past forty years, numerous attempts have been made to supplant them with Downs or Longwools, but each attempt has been abortive and a distinct range type still is to be found more firmly entrenched than ever upon the plains of the Northern States and the southern portions of Saskatchewan and Alberta. This fact would seem to indicate that this type of sheep must possess special qualifications which enable them to continue and become so firmly established on the Western Plains. What are these special qualifications? Can we recognize them? Have they any significance when applied to the keeping of sheep under domestic conditions? Somewhat similar conditions obtain with regard to breeds of cattle, both dairy and beef, and also in the case of swine.

Do we know yet which breeds can be recommended and which discouraged or is there room for some entirely new breeds distinct and different from our present kinds? What about a new breed of swine, red in colour, developed from a judicious blending of the Duroc Jersey and the Tamworth?

Then there is the question of our accepted methods of animal breeding. Are they last word or is it worth our while to study the methods employed by our competitors in animal production? Is it quite unimportant that practically all of the lamb and bacon producing countries except Canada follow the practice of crossbreeding in the production of their market animals? It seems to me that things of this kind are important—are, in fact, fundamental, and must not be ignored, but carefully investigated so that we may reach some definite and more or less unanimous conclusion with regard to them and by so doing be in a position to assist materially in formulating

an animal production policy that will have the effect of establishing our livestock industry on a very much sounder basis. Economical production is essential. To secure it, our farmers must be provided with the foundation stocks that are best suited to Canadian conditions. They must have well defined breeding policies and systems of livestock management. Do we, as Animal Husbandmen, recognize the importance of this work sufficiently and are we giving it the attention it deserves?

Report of Horse Committee

F. H. Reed
Superintendent, Dominion Experimental Farm, Lacombe, Alberta

During the last few years of high prices for wheat and coarse grains there has been a very rapid increase in the number of tractors on western farms. The slump in grain prices will force many farmers to return to the use of horses, particularly on the smaller farms. Even with the coming of the tractors the demand for horses on eastern farms has maintained horse prices at what seem to be profitable figures. It was feared a few years ago that trucks and automobiles would drive the horse off city streets but this has not been the case. The following statements from the National Cartage Company of Winnipeg and from the T. Eaton Company of Winnipeg will show why horses are likely to continue to be in demand for city delivery. Prices are still high for really good draught horses for use in the cities. Light horses, particularly saddle horses, are rapidly increasing in demand, and for high class horses big prices are being paid.

The Canadian National Cartage Company, Winnipeg, state that horses will always be employed by them for the following reasons:

1st. Within a three-mile limit horse delivery is 50 per cent cheaper than truck delivery.

2nd. $4,000 is tied up in each truck as compared with $1,800 invested in each team and wagon supplied with rubber tires and ball bearings.

3rd. The capacity of a truck is three tons, whereas horsedrawn vehicles can haul six or seven tons.

4th. When large wholesale concerns have a load for shipment comprising six tons, they want it moved with one trip and will not countenance two or three trucks pulling in to remove what one team can haul at one loading and unloading.

5th. The Cartage Company at present have approximately 160 horses and the ratio between trucks and horses is as four teams is to one truck.

6th. Large mail order and merchandising houses operating delivery services charge half of their delivery costs to advertising; therefore, they use trucks to a larger extent as many householders consider a truck is more attractive pulling up in front of their establishment than is a team of horses.

7th. The National Cartage Company use a zone system and all deliveries within a three-mile radius are allocated to horse-drawn vehicles whereas those outside of the three-mile zone are allocated to trucks.

From the T. Eaton Company, Winnipeg:

1. For the delivery of parcels within 5 or 6 mile radius the motor cannot compete with the horse, especially where there are frequent calls.

2. For long distance delivery where routes cover 50 to 90 miles a day, the horse cannot compete with the motor.

3. Frequently stopping and starting is a big factor in delivery. The power required to start a load is 6 to 10 times the power needed to keep it moving. The motor is always running, while the horse is frequently resting. The horse often guides himself while the driver is sorting parcels and "Come on Prince" will bring the horse but "Come on Lizzie" is not yet effective.

4. The average gait of the delivery horse is 4 miles per hour while the average for the motor or light truck is 16 miles per hour.

5. The useful life of a horse averages 10 years, the waggon and harness average 15 years. The average life of a delivery motor car is 7 years. The investment in horses and waggons is not over 25 per cent of the investment in motors of equal capacity.

6. A truck delivery man on an average sits down to drive 96 times in one hour for a total of 47½ minutes or 44½ per cent of his time, while the driver of a horse sits down only 5 per cent of his total time.

7. Including operation, maintenance, and fixed charges the average cost per week for a horse and waggon is $23.17 as against $69.14 for a motor delivery.

Cost of Maintaining Work Horses

The cost of maintaining work horses varies from year to year depending upon kinds of feeds available, and the amount of horse labour hours performed.

At the Morden Experimental Station in 1929 the weather favoured field work and as the horses worked many hours and were wintered largely on cheap roughage, the cost of horse labour per hour of .077 cents was pleasingly low.

At the Rosthern Experimental Station four two-year-old colts, born during the month of July 1927 were weighed at birth and at monthly intervals until they were two years old and a record kept of the feed that they consumed during this period. The feed which was consumed by the mares while nursing their colts was also included in the cost to rear these colts to two years of age, the average of which was $79.03.

The cost of horse labour per hour at the Rosthern Experimental Station during the months of June, July, August, September, October, 1929, we estimated to be eight cents. The ten horses in this experiment worked an average of seven hours each per day during this period. The total cost of feeding and maintenance per head during this period was $84.85.

Report of Beef Cattle Committee

R. D. Sinclair

Associate Professor of Animal Husbandry, University of Alberta, Edmonton.

In keeping with the policy laid down at the last Annual Meeting the activities of the Beef Cattle Committee have centered around the summariza-

tion of results of beef cattle experiments conducted at the various stations in Western Canada during the past year, together with making arrangements for some special features for the beef cattle section of the programme.

With regard to the bringing up to date of the experimental results with beef cattle the work of the Committee has not been heavy. All stations were communicated with and prompt replies received. The co-operation along this line has been splendid. The past year appears to have been an "off season" in the matter of experimentation with beef cattle. Of the various stations conducting experimental work only two report a result for the year. The results of these experiments will be stated briefly.

1928-29 Scott, Sask.

1. Comparison of Barley and Frozen Wheat for Fattening Steers.
   When oats and barley, fed in equal proportions was compared with oats and frozen wheat in the same proportions, with oat straw for roughage the daily gains were practically equal, but the grain requirement was higher by 18 pounds for each 100 pounds gain. Due to a lower cost the steers fed feed wheat returned the greatest profit.
2. Comparison of Oat Straw and Sweet Clover Hay as Roughages for Fattening Cattle.
   Steers fed sweet clover hay as compared with oat straw made 25 per cent higher daily gains and required 20 per cent less grain for 100 pounds gain, but a valuation of $10.00 per ton on the sweet clover hay prevents the sweet clover fed steers from showing as much profit as those fed oat straw valued at $2.00 per ton.

1928-29 University of Alberta

1. Comparison of Self and Hand-Feeding of Grain for Calves.
   Self-fed calves made nearly 16 per cent more rapid gains, finishing nine days earlier than those full hand-fed. Grain consumption was considerably higher when the self-feeder was used with the feed cost of one hundred pounds gain higher by 64 cents. As a result of a premium of 20 cents per cwt. paid for the self-fed calves, on account of extra finish, they returned a profit greater by 39 cents per head. Self-fed calves showed a higher dressing percentage by 1.7 per cent.
2. Comparison of Oat Silage and Oat Hay for Fattening Calves.
   These two rations gave practically the same results from the standpoint of rate of gains and feed requirement for 100 pounds gain. Silage fed calves however, sold at 45 cents per 100 pounds higher than those fed cut oat hay resulting in an increased profit of $4.14 per head. While the increased selling price was due partly to the bloom shown by the silage fed calves, the fact that they dressed out slightly higher indicates that they were slightly better finished.

In connection with a special problem which might be featured in the beef cattle section of the Society's programme, your committee decided at a meeting held in Calgary at the time of the Spring Show that the matter of

cattle finishing as a phase of beef production was of sufficient importance and interest to receive special consideration at this time. It is perhaps safe to say that the greatest problem in connection with beef cattle production in Western Canada arises out of the fact that there is no beef cattle finishing tradition in the country. The average beef producer thinks in terms of an intermediate product rather than in terms of an ultimate product and his conscience is not hurt when his cattle are marketed as stockers and feeders. It must be realized, of course, that there are areas where cattle feeding is not practicable and where feeder cattle production is the logical business, but on the other hand there are areas where the feed supply is available and where all conditions are favourable for producing finished beef where stockers and feeders are marketed regularly without any consideration as to who is going to turn them into a finished product. They may be changed as an end product in the feed lots of the corn belt, the feed lots of the packer, the feed lots of the commercial feeder or as unfinished and inferior beef in the packing plant. Then, too, there are areas where conditions are not favourable for the production of beef cattle, but where ample supplies of suitable finishing feeds may be grown and where these feeds are now being marketed in their natural conditions at considerably lower prices than they could be marketed in the form of finished beef.

Regardless of the causes which contribute to the supply of unfinished cattle which we find on our markets, the fact remains that this class of cattle is in our midst and unless we take stock of the areas where these cattle may be converted into finished beef and get the two possible factions in the cattle business together, we are not likely to make much headway in stabilizing the beef cattle business. It would appear that it may be possible to work out a closer system of co-operation between the man who has unfinished cattle to market and the man who has feed which can be converted into good beef at a profit. As the programme proceeds it is hoped that more light will be thrown on this possibility.

Cattle finishing is closely linked up with the comparatively new policy of beef grading and those in attendance will no doubt be anxious to learn of the progress made and problems encountered to date.

In formulating a beef cattle section of the Society's programme your Committee had in mind that a composite of the views of parties interested in various phases of finished beef production would prove enlightening and instructive for the members at large.

Changes in Ranch Practices to Meet the Consumer's Demands

L. B. Thomson

Field Husbandman, Dominion Range Experimental Station, Manyberries, Alberta

Last year at your annual meeting in Winnipeg, I presented a paper dealing with the economics of the Range Livestock Industry, with special reference to the importance of the different factors of management and how they affect the business. Since that time I have had an opportunity of collecting more data on the cost of production of range cattle from ranchers located in southeastern Alberta and southwestern Saskatchewan.

In view of the changes in demand that have taken place the past few years on our markets, from heavier cattle to lighter cattle, and also in view of the new Beef Grading Policy, the age at which cattle are marketed is of considerable concern to the stockman, because under his existing conditions a change in the policy of marketing means a decided change in the ranch management program.

In Alberta and Saskatchewan there are a few ranchers who are operating on a cow and calf basis, but the majority of them sell their cattle at the age of two or three years. There are a number of them who are seriously considering a change, but they have not been able to change their production plan in the way of increased winter feed supply to insure against the greater risk and increased feed consumption required when operating on a cow and calf basis.

Summary of Data Presented

1. For the ranches studied on the short grass plains and where the supply of winter feed is a limiting factor in the business, and where cheap grass is available for summer grazing, the raising and selling of the heavy steer is the more profitable policy at the present time.

2. The producing of older steers require less investment in land for the raising of winter feed, lower investment in improvements and equipment and less labour costs. Once a steer has passed the yearling age he practically looks after himself.

3. On the cow and calf basis there is a greater risk of loss and with a larger cow herd the chances for a higher calf crop percentage are not so good. The difficulty of obtaining efficient hired help enters in.

4. To change to a cow and calf basis under present conditions would mean further investment in development of areas of land for the growing of winter feed. This could not be done in most cases in a year, but would take several years. With such expenditures the cost of a calf would be increased.

5. As a general rule and in the studies made, there is a greater loss in the cow herd than there is in the steer herd. By having a good feed supply and of course depending on the individual management of the ranch, the losses would be kept in line with the present losses of older cattle. The opinion has often been expressed that the losses for cows and calves would not be less.

6. For a rancher to change his policy to a cow and calf basis he would require a greater premium on his calves than he has received up to the present time. Or if the demand for lighter cattle is so great that heavier cattle are discriminated against, it may then pay the rancher to change his policy. Up to the present time it has not paid him to do so.

7. If there is to be a change it must be gradual and sufficient security of price given the rancher over a long period of time. Such a drastic change means considerable to the business. The herds of cattle on the range have taken years to build up and any tearing down or changing affects this program very materially.

8. Yearlings are very seldom sold off the range and in the ranches studied, no yearling cattle were sold. The greatest cost in raising an animal is up to the yearling age. From then on the cost of production decreases.

9. The importance of the income from fat dry cows must not be overlooked. This is as important as any other part of the business. If they are discriminated against, more so than heavy steers, it will affect the ranch on a cow and calf basis, more so than on a heavy steer basis.

10. The selling of lighter cattle such as calves and yearlings in preference to heavy steers of the ranches studied in order to meet the changing demands, can only be brought about by a decided increase in price for the lighter cattle. The experience up to the present has not justified the ranches studied to sell their lighter cattle.

11. Where winter feed is a limiting factor in the ranch business, it is not good business to try fattening and finishing the lighter cattle for market. The opinion has often been expressed that "growing cattle" is one business and "fattening cattle" is another. The number of acres it takes to graze an animal for the year determines the range management programme. For years there has been a gradual decline in the carrying capacity of the ranges on the short grass plains and the growing of winter feed has served not only as security against loss in the winter period, but has also assisted in making more economic use of the range. Therefore the carrying capacity and the economic use of the range by the different classes of stock influences the production policy. Heavy steers can often use range pastures more efficiently than lighter cattle and cows and calves. There are also areas where cows and calves are better adapted, so that adaptability of the range under use must also be considered.

Conclusion

I have endeavoured to analyse the business of the rancher who is now selling heavy steers and what a change in ranch practice means to him under the conditions which I have referred to. Up to the present time these men have not seen their way clear to change their production policy. Price, no doubt rules any change of policy, providing conditions under which a man is operating will permit a change. If the demand for calves and lighter cattle is so great, then the price should change accordingly and when this is so I firmly believe that the ranchers will adjust their policies to meet the demand. It is not advertising and publicity that will change the rancher's program of production, it is dollars and cents for the type of animal produced. In the interest of the producer, further studies should be made in order to present a fair picture of the industry and whether or not a change in the selling end of the business fits in with the producing end.

Report of the Dairy Cattle Committee

J. M. Brown
Associate Professor of Animal Husbandry, Manitoba Agricultural College Winnipeg, Man.

The committee on dairy cattle begs to submit the following report, the chief purpose of which is to bring to the attention of animal husbandmen in Western Canada the existence of a disease affecting cattle and known to be

a dietary deficiency disease. Reports have been received by us each winter, in some years more numerous than in others ,of cattle exhibiting abnormal symptoms, including depraved appetite or pica. Conditions of this kind have long been recognized elsewhere, particularly S. Africa, Australia, New Zealand, China, Norway, and Germany. Presumably because of the manner in which the disease affects the bones, it had been assumed (although experimental proof was lacking) that the disease was a manifestation of Calcium deficiency in the diet.

The extensive investigations of Theiler in S. Africa (*1*) and Eckles (*2*) and associates of Minnesota leave no room for doubt, however, that phosphorus and not calcium is the deficient element in this dietary disease.

Symptoms

The typical symptoms described by various writers are depraved appetite manifested in the tendency to chew bones, wood, leather, dirt, etc. So great is this craving apparently for something not supplied in the feed that on the S. Africa veldt it gives rise to another disease known as "lamziekte" which is acquired by the habit of cattle worrying the putrifying flesh of carcasses in order to get at the bones. Other symptoms are stiffness in the hind quarters; swelling of the joints; a harsh dry coat, dull eyes, unthrifty general appearance, leg and rib bones easily broken, decreased milk yields. One can frequently hear the joints of affected animals creak and when forced to move pain is manifested in the tendency to grunt. The disease is generally observed to be more prevalent following periods of deficient rainfall and symptoms are most acute towards the end of the Winter season following periods of feeding dry feeds. Cattle usually recover during the pasture season and are as a rule about normal again by Fall.

Investigations Concerning Causes

Both Theiler and Eckles (working independently of each other) have shown that the cause of depraved appetite is a lack of phosphorus in the forage. Theiler demonstrated that the depraved appetite could be overcome by feeding wheat bran, bone meal, sodium phosphate or even phosphoric acid while lime carbonate seemed to have a detrimental effect. Eckles found that in the affected regions of Minnesota the soils are deficient in phosphorus, that the forages grown thereon are deficient in phosphorus, that the disease can be produced experimentally by feeding roughage from affected districts to groups of cows which are quite normal at the commencement of the experimental period and that the disease can be prevented and cured in districts affected over a period of years by supplementing the ration with some form of phosphorus such as bone meal or other phosphatic compound.

Suspecting that cattle owners in Western Canada might have suffered considerable loss through this disease following the dry summer of 1929, your committee have undertaken to secure information relative to the disease as encountered in Manitoba. The first procedure was to broadcast by radio the nature of the disease and the conditions under which it is likely to develop. At the same time response was solicited from those who had observed any of the symptoms in cattle in this or previous years. Immediately following this broadcast some twenty reports were received of the prevalence of this disease during the past winter.

Some of the reports indicated that whole municipalities were involved. It appeared, therefore, that many cattle had suffered and with a view to securing more complete information relative to the affected areas in Manitoba, the particular conditions obtaining where outbreaks were severe etc., a questionnaire was prepared and distributed to 422 milk and cream producers specially selected by reason of location in all parts of the province. This meeting with but slight response, a follow-up letter was sent out and eventually a total of 169 completed questionnaires was received. Study of these brings out the following facts:

Of a total of 169 cattle owners, 106 or 62 per cent report the occurrence of phosphorus deficiency disease during the past winter and of this 106 total, 32 or 33 per cent report reproductive troubles as accompanying condition.

When charted it is found that the incidence of the disease is greatest in territories where the soils especially lack phosphorus. Thus approximately ninety per cent of the correspondents located in the territory between lakes Manitoba and Winnipeg and along the western and eastern shores of these lakes respectively, report occurrence of the disease.

It is significant that the few owners from this region reporting freedom from the trouble, are feeding considerable grain including bran and shorts.

Isolated positive reports have come from districts where the soil is known to be relatively high in phosphorus, but in such instances one commonly finds that the ration fed is almost or entirely one of roughage and such of the common variety. Under such circumstances following a very dry summer, it is not surprising that the disease has developed.

Your committee find that the evidence points to the animal industry of Manitoba having suffered considerable loss from this disease during the past winter and there are many reasons for supposing that the situation is no less acute in the provinces of Saskatchewan and Alberta.

It should be noted that the disease can be prevented and cured by feeding adequate amounts of either organic or inorganic phosphorus, nevertheless this must be regarded as a temporary expedient and ultimately the solution of the problem must be one of restoring or adding phosphorus to the deficient soils.

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Infectious Abortion Research

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Infectious Abortion of cattle may be defined as an insidious disease, which without usually revealing any premonitory symptoms causes the premature expulsion of the fetus in pregnant animals. The cause of the disease is a bacterium first isolated in 1896 by Bang, and now variously known

as *Bacterium abortus, Brucella abortus, Alcaligines abortus* and the Bacillus of Bang, all of which refer to the same organism. The premature expulsion of the fetus is a serious economic loss to live stock owners, and among other sequalae of the disease is the nullification of efforts to produce a higher type of cattle. Also there is the Public Health question, that is, the transfer of the disease from animal to man, which is assuming increasingly important proportions, as the epidemiology of Undulant Fever in man is studied.

Previous to 1928 sporadic attempts had been made by the Pathological Division of the Health of Animals Branch, to test as many herds as were available, with the hope of collecting and correlating data along with the distribution of vaccines, in an endeavour to study the best methods of prophylaxis and control. Unfortunately, nothing came of these attempts, since owners of herds containing reactors, employed the knowledge obtained as a result of the test to rid themselves of reacting animals in a manner hardly fair to unsuspecting purchasers and to susceptible live stock generally and because at that time there was no agreement between the Health of Animals Branch and the various owners for whom tests were made, as to the disposal of reactors, nor legislative regulations for the control of the disease, the testing of private herds and the distribution of vaccines were discontinued.

A few years ago, alleged cures of one kind and another were foisted on credulous live stock owners by either ignorant or unscrupulous vendors, and although the results following the use of these nostrums were quite often good, in no instance would they have been different, had no treatment been administered, for the various "cures" were based on the knowledge that cattle after infection generally became immune and those animals which aborted rarely did so a second time. It was also on this knowledge that vaccines have been advocated and employed with varying amounts of success.

At first, vaccination against abortion disease was embraced with great expectations as a probable method of prophylaxis and control, but as the results were studied over longer periods of time, it became evident that these expectations remained unrealized. Convincing proof, I think, of the unrealized hope will be found in the recent decision of leading Biological Houses to discontinue the manufacture of abortion vaccines. The indifferent results following vaccination may be attributed to several factors, some of which were the variable and uncontrollable immunity reactions of individual animals, the impossibility of maintaining a standard viability of the vaccines (dead organisms or bacterins being generally conceded worthless) under general usage and the promiscuous vaccination of herds.

These then were the chaotic conditions prevailing, when in 1928, through the co-operation of the Experimental Farms Branch, an experiment of some magnitude was made possible to our Division. This comprised the testing by suitable serological methods of all cattle on the various Farms throughout the Dominion, with the segregation or elmination by slaughter of all reacting animals. Definite conclusions at the present time would be unwarranted, but I have no doubt that in the final analysis, the slaughter policy will be found justifiable in this particular experiment.

As regards the methods employed for diagnosis, two serological tests have been applied to samples of blood obtained from the Experimental

Stations, viz:— the Agglutination and the Complement Fixation tests. The former is comparatively a simple test to perform, while the latter is more complicated, both however require that sterile blood samples be obtained from the animals to be tested. Neither test has any great advantage over the other, but used to supplement each other more accurate diagnoses are possible. Other methods of diagnosis, such as the intradermal and subcutaneous inoculation of various products of the infective organisms have been advocated, but the results in other hands than those of the originators have never justified the claims made for their specificity, and in no case are they as accurate as the serological tests.

In speaking of abortion, there appears prevalent among stock owners the idea that all abortions are due to *B. abortus*. This is erroneous as there are numerous other causes which might produce abortion which may be enumerated as follows: (1)Injuries, (2) Nervous diseases, (3) Diseases of the genital organs and anatomical malformations, (4) Infectious Diseases other than *B. abortus*, (5) Mineral deficiency and food poisoning, (6) Incompatibility of the bull. To state however the actual percentage of abortions due to *B. abortus* is impossible as there is not enough reliable data extant, and even if such data were available it would probably be misleading, for abortions in individual herds due to *B. abortus* vary considerably depending on the virulence of the infective strain, the resistance of the cattle, and also the length of time infection had been present in the herd.

For these reasons the result of a herd test for Infectious Abortion is quite often a disappointment to the owner when compared to the actual abortions which have occurred, and there is a tendency to discredit the reliability of the serological tests as a method of diagnosis, particularly when it is found that some of the most valuable animals which had never aborted are classed as reactors. The fact, however, that the majority of reacting animals are spreaders of infection, even if they do not abort, precludes the possibility, except in the occasional herd, of ever entirely freeing a herd from the disease should these animals be retained.

It must therefore be kept in mind when analysing the result of a serological herd test for infectious abortion, that a reactor is not necessarily an aborter, but is a potential spreader of infection. However as just indicated, there is a certain percentage of reactors which will neither abort nor disseminate infection and to this group a great deal of time and effort have been expended in an endeavour to differentiate these animals from other reactors, by their serological reactions, but so far not markedly successful.

To give a more lucid conception of the disease as it appears in a reacting herd, I have prepared the following diagram classifying animals, as they are usually found in such herds, according to their serological reactions.

A study of the above diagram will show that it is quite possible to have aborters and non-breeders among non-reacting animals, (and likewise in a non-reacting herd) on the one hand, and reactors which neither abort nor spread infection (or even an entire herd of such animals) on the other.

From the result of studies now in progress it has been found possible to cause the sera of healthy animals, inoculated with certain products of the bacterium, which causes the disease, to give the same serological reactions

as animals inoculated with the organisms. This gives some promise for further researches in possible methods of prophylaxis, but as this work has been only recently commenced no conclusions can yet be made.

REACTING HERD

Non-Reactors		Reactors		
Aborters & Non-breeders	Non-Aborters	Aborters & Non-breeders	Non-Aborters	Non-Aborters
Possible causes:				
(1) Injuries (2) Nervous conditions (3) Diseases of genital organs and anatomical malformations. (4) Infectious Diseases other than *B. abortus*. (5) Mineral Deficiency of food and food poisoning. (6) Incompatibility of bull.	(1) Immune to infection (2) Not infected	(1) Spreaders of infection	Spreaders of infection	Not spreaders of infection

Lacking a cure or stable immunizing agents at the present time, there is no question but that the present policy as carried out in connection with the Experimental Farms herds, will free the herds of *B. abortus infection*. However it is not improbable that sporadic abortions will occur, in non-reacting herds, but these will be due to causes other than *B. abortus* infection, and I believe that an important percentage of these, particularly in the Prairie Provinces, will be due to mineral deficiency in the fodder supplied animals.

It is also possible that after your herds have passed several clean blood tests, that abortion due to *B. abortus* will suddenly appear despite the fact that reasonable precautions have been observed to prevent infection from adventious sources so that it might be as well to know the possible sources of infection and be prepared to guard against them. These will be found in other domesticated animals besides cattle, as horses, swines, goats and even poultry are liable to infection with *B. abortus*. Further, recent researches on a closely related organism, have indicated infection by way of the unbroken skin, and if correct and applicable to *B. abortus* of cattle would have an important bearing on the spread of infection among cattle, and the milker, whether machine or man, should be suspected in any mysterious outbreak.

In conclusion, a word as regards the bull. It is the concensus of opinion that the part played by this animal in the spread of infection, is that of mechanical carrier, nevertheless there is some possibility of a reacting bull

infecting animals with which he has contact, and in my opinion he should not be maintained in an otherwise non-reacting herd until more definite information is known regarding the role this animal plays in disseminating the disease.

Report of Sheep Committee

A. M. Shaw

Dean of the Faculty of Agriculture, University of Saskatchewan, Saskatoon

With regard to the experimentation being carried on by the various Western institutions from which we have heard, no new results of a complete or actually definite character have been secured. We make this statement after careful consideration of the various experiments in progress and, although we realize that much good work has been and is being done, we still feel that the research workers are very far from being in a position where they can successfully answer the many intricate queries relating to sheep husbandry, put to them by the farmers of Western Canada.

There are, in the opinion of your committee, a number of fundamental problems that must be solved before the sheep industry of Western Canada can make any considerable progress.

1. A study and careful comparison of the various breeds of sheep keep under identical conditions in the same flock on both farm and ranch. The various breeds to be of the same age at the beginning and the trials to be carried on as long as the ewes continue to breed regularly. In other words, for the entire lifetime of the whole flock, the object of the experiment being to establish, if possible, the definite superiority of certain breeds or types and the elimination of the undesirable kinds.

2. Cross breeding experiments for market lamb production:

(a) To compare with purebreds of each of the parent strains.

(b) To ascertain whether or not the so-called "hybrid vigor" is present in the F_1 generation.

(c) If it does exist, whether or not it is of economic importance .

(d) If crossing is desirable, to discover which crosses produce the best results and why.

3. Invesitgations dealing with the management, feeding and care of the ewe flock under farm conditions.

4. Breeding experiments designed to throw some light on the inheritance of heavy and light birth coats in lambs.

These are only a few of the many problems but we feel that they are more or less fundamental and must be solved before any very definite sheep breeding policy for Western Canada can be evolved. We hope that a lively discussion may be forthcoming as a result of this report.

Report of the Swine Committee

H. E. Wilson

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At the last annual meeting of the Society, a suggestion was made that the work of the next Swine Committee should be the collection and compilation of data comparing spring and fall litters showing the mortality, cost

of production, prices and profits. Such a compilation in the opinion of the Swine Committee is most difficult because of the fact, that, in presenting a report of this nature it would be necessary to relate the work of one Station to another and present a tabulation of results based on averages, which, as previous Swine Committees have learned, is not practical nor perhaps even desirable. Experience has indicated that it is practically impossible to average the results from two or three years work on one project as reported from one institution, to say nothing of averaging the results of a project from all institutions.

In view of these circumstances it was decided that the Committee should for this year attempt to summarize a recently completed experimental project which had been studied at a number of Western institutions.

It was deemed timely and advisable to summarize the results of feeding tests conducted at many of the Western institutions were "wheat as a hog feed" was studied.

The Committee wishes to extend its thanks to the various institutions for their co-operation.

Summary

(1) Pigs can be grown and finished satisfactorily on feed wheat as a sole grain if the dairy by-products or tankage are also provided.

(2) The feeding of feed wheat produces no ill effects on the health of the pigs nor does it produce any marked difference in the type of the hog as compared with other feeds.

(3) For finishing pigs, feed wheat promotes more rapid and more economical gains than barley chop.

(4) Feed wheat with a protein supplement has a place in the ration of the growing and fattening pig and gives good results as compared with a feed mixture composed of equal parts oats and barley.

(5) The addition of oats to feed wheat in the proportions of 1 to 2; 1 to 3 and 1 to 4 tended to reduce the gains and increase the cost per 100 pounds of gain. Oats did not seem to be necessary to overcome the "gummy" tendency of the wheat.

(6) For growing and finishing pigs sound wheat promotes more rapid gains but not as economical gains as feed wheat.

(7) When pigs are allowed to choose between oats, wheat and barley during their entire growth period, they show a decided preference for wheat.

(8) Corn, because of its high price, is not as satisfactory a hog feed as the home grown feeds—wheat, barley and oats.

The Swine Industry in Western Canada

C. M. Learmonth
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As long as people of the world continue to eat food, then pork products will always be a part of their diet; as long as the inhabitants of the British Isles have the money to buy food, bacon will be on the menus and lastly as long as Canadians and Canada's increasing tourist friends retain keen appetites the consumption of pork products will continue apace. The con-

sumption per capita of pork products in Canada has steadily risen: 1925, 72.47 lbs.; 1926, 75.23 lbs.; 1927, 81.43 lbs.; 1928, 82.48 lbs.

Canada's hog population has varied very little in the last five years and the percentage in Western Canada compared to the Canada total shows only a slight variance.

TABLE 1.—*Hog population.*

Year	Canada	Percentage Western Provinces
1925	4,426,148	40.8
1926	4,359,582	37.8
1927	4,694,789	38.3
1928	4,497,367	37.1
1929	4,381,725	39.5

Further dividing the population figures you will find Alberta has the largest population followed by Saskatchewan then Manitoba and British Columbia.

TABLE 2.—*Hog population in Western Canada.*

Province	1925	1926	1927	1928	1929
Manitoba	298,507	304,434	387,260	330,803	295,330
Saskatchewan	610,973	597,660	616,603	602,156	599,909
Alberta	854,902	701,277	742,671	680,000	770,233
British Columbia	41,868	45,528	49,654	53,652	63,136

Practically all hogs find their way to packing plants and the inspected slaughterings are fairly indicative of the commercial industry. The table below shows an increase in Western Canada for the last two years.

TABLE 4.—*Inspected slaughtering of Hogs.*

	Western Canada	Canada
1925	899,419	2,641,731
1926	855,763	2,491,425
1927	859,427	2,540,342
1928	1,023,711	2,547,024
1929	1,035,603	2,353,161

Some forty years ago in the Province of Ontario those in close touch with the Swine Industry decided that in the production of hogs Canada's position would be the soundest if hogs producing the maximum amount of bacon were produced. Consequently for many years Ontario in particular produced bacon hogs and became a factor on the export market in Great Britain. With the coming of the world war and the immediate requirements for war purposes it was a question of pork tonnage rather than emphasis on quality. The situation was such that in 1921 the Dominion Department of Agriculture called the National Swine Conference and out of that conference grew that present national bacon hog policy. Six distinct features have come into existence.

1. The establishment of the Joint Swine Committee of Canada.
2. Principle of grading endorsed.
3. The establishment of grades, 9 in number.
4. A fixed differential in payment between the select and bacon grade. other differentials at market values.
5. Grading system in effect at all stock yards and packing plants.
6. Regulations covering buying and selling hogs.

From the meetings of the Joint Swine Committee there gradually came to the surface the need for some authentic work on a national scale in so far as the purebred business was concerned. The Dominion Department was asked to institute a board for the Advanced Registry of Swine.

The board shall undertake to measure accurately and record authentically the performance of purebred swine entered in the Advanced Registry. The purpose is briefly 3 fold.

1. To find out a sow's productive capacity.
2. Capacity of sow's progeny for early maturity.
3. Quality of the progeny revealed in a slaughter test.

At the commencement of this work it was decided to limit entries for at least a year to herds owned by the Government and public institutions and to endeavour to find out a basis upon which qualification could be made. Last year 235 sows were entered and 124 passed all tests. Standards have now been adopted and all records are reviewed before the board in annual meeting.

This year it was decided to allow purebred breeders throughout Canada to enter sows and the work is progressing very satisfactorily. From what I can learn this work is more defined and is an improvement on Danish methods and it will be possible, shortly, to secure breeding stock on which there has been an accurate and authentic record in every respect.

Live Stock Experimentation and Interpretation of Results

G. W. Wood

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Pearl states that "an experiment which takes no account of the probable error of the results is inadequate and as likely as not to lead to incorrect conclusions".

It has been found that in the average live stock feeding trial that the gains in weight show an uncontrollable variability of about seevnteen per cent. That means that when the average mean gains in the lot say are 100 lbs., that the animals in the group will show an average variation from this mean gain of 17 pounds.

The four most important factors to be determined in working out experimental feeding data are:

1. The mean average gains.
2. Variability of the gains within the group.
3. The Probable error of the mean gains.
4. The Probable error of comparison between two or more groups.

Examples

Mean Average Gain

Initial Weight	Final Weight	Gains	Deviation from mean
50 lbs.	210	160	20
50	190	140	0
50	170	120	20

Total Gain 420 lbs.

$$\text{Mean Average Gain} \quad \frac{420}{3} = 140$$

$$\text{Standard Deviation} = \sigma \quad \sqrt{\frac{\Sigma\ F\ D^2}{N}}$$

$$\sqrt{\frac{20 \times 20 + 20 \times 20}{3}} = 16.33$$

$$\frac{\text{Probable Error of Mean}}{\text{P.E.m.}} = \frac{.6745 \times \sigma}{\sqrt{N}}$$

$$\frac{.6745 \times 16.33}{\sqrt{3}} = 6.36 \text{ or } 140 + - 6.36$$

This means that one-half of the mean gains of the pigs will fall between 146.36 and 133.64 lbs.

$$\text{Probable Error of difference or comparison} = \sqrt{P\ E^2m + P\ E^2\ m}$$

	Mean Gain	P.E. of mean
Ration I	140	6.36
Ration II	150	3.18
	10	

$$\sqrt{6.36 \times 6.36 + 3.18 \times 3.18} = 7.09$$

The mean difference in gains between the groups should be at least three times the probable error of difference.

The standard deviation is a term which indicates the variability of the gains of animals in a group, while the probable error indicate what weight or significance should be given the results. Groups of animals showing a large variability in gains necessarily have a high standard deviation and a large probable error.

To measure the differences in the feeding value of any ration ,feed or factors, one must have a close check on the variability of the animals within the groups in order to determine the direct influence of the feed or factors studied. To measure small differences in feed values, one must have either a large number of animals per lot or great uniformity in gains in the group. Both of these factors give a low probable error. The following table, based on experimental results, has been drawn up by Mitchell and Grindley of Illinois, which gives the number of animals required in a lot to accurately measure differences in values of rations.

Per cent difference between average lot gains which it is desired to measure	Sheep	Steers and Hogs
50	2	1
40	2	2
30	4	3
20	8	5
17.5	10	7
15	14	9
12.5	20	13
10	31	20
7.5	54	36
5	121	80
2.5	482	317

According to this table it will be noted that where group or lot feeding is followed and it is desired to measure small differences, a very large number of animals are required in each lot or the experiment repeated a number of times with small lots and the whole summarized statistically. With a very large number of animals the probable error is reduced to a minimum thereby permitting small differences to be observed and measured accurately.

It has been found by Crampton of Macdonald in feeding lots of pigs, that one of the chief causes of the high variability of animals in group feeding is due largely to differences in the amounts of feed eaten by the different animals in the group. In other words, he found that large gains were associated with high food consumption. In group feeding we assume that all animals eat the same amount of feed, which has been found to be incorrect. Crampton also found that in individual feeding where the feed to each animal is measured and the results based on the mean gain per 100 pounds of feed consumed, that the variability of the results were very much less than with the group fed pigs. By individual feeding he was able to reduce the standard deviation and probable error to a point where small differences in the feeding value of a ration could be measured. Crampton in his conclusion on individual feeding makes the following statements—"It was possible by individual feeding to reduce the probable error of the mean gains of about 5 per cent in the case of the group fed pigs to between 1 and 2 per cent, according to the length of the feeding period involved. With probable errors of 5 per cent and demanding odds of 30 to 1 there must be a difference between the mean gains of comparative lots of 22 per cent before any difference can be considered due to anything but uncontrolled variation, while a difference of 4 per cent is all that is required when the errors stand at 1 per cent of the mean gains."

Sommerfeld of Manitoba calculated statistically steer feeding results for three successive years. In these trials he assumed that all the animals within the groups ate the same amount of feed. In all cases he found high variability in gains resulting in large probable errors. The difference between the mean average gains of the groups was very little larger than the probable error of the means, which in other words means that the differences in gains were not large enough to indicate anything. To reduce the

probable error, one must feed very large groups or feed small groups individually.

Frequently wrong conclusions are drawn from the results of live stock experiments where group feeding is followed and biometry not used in evaluation results.

Examples of experimental feeding of pigs where results are computed by three different methods:

1. Group feeding—no statistical methods used.
2. Group feeding—results based on assumed feed eaten and variability in mean gains not corrected by feed factor.
3. Individual feeding—Variability based on the mean gain per 100 pounds of feed eaten or the mean pounds of meal required to produce 100 pounds gain.

EXAMPLE 1.

	Lot 1	Lot 2
Initial weight	150 lbs.	150
No. of pigs in lot	3	3
Final weight	570	600
Gain	420	450
Feed required per 100 lbs. gain	400	380

EXAMPLE 2.

Lot 1.

Pig No.	Initial Wt.	Final Wt.	Gain	Assumed Grain eaten per pig	Gain per 100 lb. grain
1	50	210	160	560	28.5
2	50	190	140	560	25.0
3	50	170	120	560	21.5

$$\textit{Standard Deviation} \quad \sqrt{\frac{3.5 \times 3.5 + 3.5 \times 3.5}{3}} = 3.84$$

$$\text{P.E.m.} \quad \frac{.6745 \times 3.84}{\sqrt{3}} = 1.5$$

Lot 2.

Pig No.	Initial Wt.	Final Wt.	Gain	Assumed Grain eaten per pig	Gain per 100 lb. grain
1	50	210	160	570	28.07
2	50	200	150	570	26.31
3	50	190	140	570	24.55

$$\textit{Standard Deviation} \quad \sqrt{\frac{1.76 \times 1.76 + 1.76 \times 1.76}{3}} = 1.43$$

$$\text{P.E.m.} \quad \sqrt{\frac{.6745 \times 1.43}{\sqrt{3}}} = .557$$

$$\text{P. E. of Difference} \quad \sqrt{1.5 \times 1.5 + .557 \times .557} = 1.6$$

Difference in gain between the two lots per 100 pounds of grain consumed = 1.31 lbs.

Probable error of difference = 1.6

Difference necessary between two groups to be significant = 5.072*.

EXAMPLE 3.

Lot 1.

Pig No.	Initial Wt.	Final Wt.	Gain	Feed eaten per 100 lbs. gain
1	50	210	160	395
2	50	190	140	400
3	50	170	120	405

$$\sigma \sqrt{\frac{5 \times 5 + 5 \times 5}{3}} = 4.08$$

$$\text{P.E.m.} \quad \frac{.6745 \times 4.08}{\sqrt{3}} = 1.59$$

Lot 2.

Pig No.	Initial Wt.	Final Wt.	Gain	Feed per 100 lbs. gain
1	50	210	160	375
2	50	200	150	380
3	50	190	140	385

$$\sigma \sqrt{\frac{5 \times 5 + 5 \times 5}{3}} = 4.08$$

$$\text{P.E.m.} \quad \frac{.6745 \times 4.08}{\sqrt{3}} = 1.59$$

$$\text{P.E. of difference} = \sqrt{1.59 \times 1.59 + 1.59 \times 1.59} = 2.25$$

Difference in amount of grain to produce 100 lbs. gain = 20 lbs.

Amount of difference necessary to be significant 2.25 × 3.17 = 7.13 lbs.

THE RATE OF GROWTH IN RELATION TO THE PROTEIN REQUIREMENTS OF CHICKS

M. C. HERNER

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This paper read at the meeting of the Society, will appear at a later date in Scientific Agriculture.

LA MALADIE DE BANG*

F. M. Gabriel
Ecole Vétérinaire de la Province de Québec

L'importance économique de la maladie de Bang, les connaissances acquises en ces dernières années sur sa nature, l'intérêt que lui portent les éleveurs, l'indiquent au premier chef parmi tant d'autres sujets susceptibles de retenir notre attention.

Aux Etats-Unis, il y a quelques années, on estimait que cette seule maladie causait des pertes évaluées à *vingt millions* de piastres. En 1920, ces pertes se chiffraient à *soixante-quinze* millions; actuellement, elles atteignent l'énorme chiffre de *quatre-vingt-cinq* millions. Pour dire vrai, on ne connait pas exactement les pertes causées par l'avortement; pour en faire une estimation précise, il faudrait connaître le nombre de vaches qui avortent, la diminution de la production laitière qui en résulte, le nombre de vaches qui meurent à la suite de l'avortement, la valeur des veaux manqués.

L'avortement qui cause ainsi des ravages si considérables dans nos troupeaux n'est qu'un symptôme qui relève des causes les plus variées: insuffisances physiologiques, blessures, infections diverses. De nombreuses maladies infectieuses, en effet, ne permettent pas à la gestation de suivre son cours normal. Ces causes générales éliminées, des avortements peuvent encore se produire, se répéter, revêtir l'allure d'une maladie contagieuse, et c'est à cette seule manifestation que l'on réserve le nom d'avortement contagieux ou épizootique.

On admet assez généralement que c'est une maladie spécifique, c'est-à-dire déterminée par un microbe particulier. Toutefois, cette manière de voir ne saurait être admise sans réserve, sans conteste non plus. Si l'on trouve bien souvent chez les avortons, dans les enveloppes, chez les vaches avortées, le bacille spécial de l'avortement, il y a bien des cas où ce microbe fait défaut, est remplacé par d'autres microbes inconnus ou appartenant à la flore banale des cavités du corps qui en sont infectées.

Il y a quelques années, le Dr. Williams, de l'Université de Cornell, qui s'est fait une spécialité des recherches sur les animaux reproducteurs, a basé sur cette constatation étiologique une conception nouvelle de l'avortement contagieux. A son sens, l'avortement n'est que l'une des manifestations susceptibles de survenir chez les femelles dont les organes génitaux sont malades. L'auteur compare l'infection des organes reproducteurs à l'infection des autres organes. L'avortement, souvent méconnu, à toutes les périodes où le veau est microscopique, ou encore lorsqu'il arrive à la veille du terme de la gestation, la non-délivrance dans bien des cas, voire même l'infection des nouveaux-nés, seraient d'origine intra-utérine. Cette manière de voir a pour elle l'insuccès des tentatives prophylactiques qui ont été drigées, basées sur le principe de l'avortement comme maladie spécifique.

Cette théorie mérite un sérieux examen en raison de l'autorité de celui qui l'a formulée. Mais les plus nombreuses recherches qui ont été faites sur l'avortement et dont nous voulons dire le dernier mot son inspirées de l'idée classique de la spécificité de la maladie.

Sous son type le plus fréquent, l'avortement contagieux est fonction d'une infection par le "Bacillus abortus", que l'on appelle aujourd'hui *"Brucella abortus"*. L'avortement qu'il provoque a son nom scientifique, la "Brucellose bovine"; mais on devrait plutôt l'appeler la "Maladie de Bang", du nom de celui qui a découvert le bacille.

Pour avoir un idée exacte des données actuelles sur cette maladie, il faut recourir aux documents scientifiques, aussi nombreux qu'intéressants, qui ont été publiés; nous choisirons dans la masse. Pour une large part, les procédés actuels de prévention contre la maladie de Bang se fondent sur ces acquisitions nouvelles: ils seront exposés sommairement.

L'avortement épizootique, à l'unanimité moins une voix, est considéré, non plus comme une pure infection utérine, comme une maladie des enveloppes et du foetus, mais bien comme une infection générale chronique. (Vallée). Si la vache en gestation est le terrain de choix pour son évolution, le mâle peut en subir les atteintes. L'infection par le *Brucella abortus* se traduit d'ailleurs, non seulement par des avortements, mais aussi par de la stérilité, par des accidents de non-délivrance, par une mortalité spéciale chez les nouveaux-nés. Mieux, l'avortement n'est pas une conséquence inévitable de l'infection, et un très grand nombre de femelles, certainement infectées, n'avorteront pas.

La marche de l'infection chez un animal malade subit une évolution; elle varie suivant que l'on a affaire à de jeunes sujets, ou à des mâles et des vaches adultes, en gestation ou non.

Les jeunes bovins des deux sexes et les mâles jouissent d'une remarquable aptitude à se libérer de l'infection. Les génisses vierges elles-mêmes triomphent aisément de la contamination; seul, l'organisme de la vache en gestation est entièrement apte à l'évolution de la maladie. De fait, de tous les organes de la vache, aucun n'offre un terrain plus favorable à la multiplication du Brucella abortus que l'utérus gravide. Aussi, à l'heure de l'avortement ou d'un vêlage d'apparence normale, et dans les jours qui suivent, la vache infectée disperse-t-elle en abondance le germe de la maladie. Elle provoque ainsi une large contamination du milieu qui l'héberge. C'est là la source la plus active de la contagion.

Survient une période d'accalmie. L'utérus infecté s'épure très vite, et, après quelques semaines seulement, l'on n'y trouve plus le bacille de Bang. Combien de temps dure cette élimination par le mucus vaginal? D'après une compilation de statistiques, on trouve comme moyenne de 3 à 4 semaines, avec un maximum de temps de vingt-cinq jours. Combien de temps avant le vêlage une vache jette-t-elle dans son milieu le germe de l'avortement? Nous n'avons actuellement aucune donnée pour répondre. A ce propos, qu'on me permette de signaler le danger de mettre sur le même pâturage des vaches pleines taries et des taures en gestation.

Après l'élimination utérine, le Bacille de Bang se rencontre encore dans le pis et dans les ganglions supra-mammaires des vaches infectées. Désormais "porteurs de germes", ces animaux sont susceptibles d'une élimination virulente, de rejeter des microbes nocifs, infection qui se prolongera, en certains cas, durant des années. Leur lait véhicule le bacille abortif dans un fort pourcentgae. Il est inutile d'insister sur le danger que

présentent de pareilles vaches. Ce sont là des éléments redoutables—autant qu'ignorés—de la permanence de la contagion dans une étable infectée.

Ici se présente une question que je ne puis passer sous silence: si le lait des vaches contaminées véhicule le bacille abortif, *ce microbe, ce virus est-il dangereux pour l'homme?*

De nos jours, des expériences sérieuses et suivies, faites un peu partout, signalent la transmissibilité à l'homme du virus en question. Et quand je parle de transmission de ce virus à l'homme, je ne veux aucunement insinuer que ce virus peut avoir, chez la femme, l'effet nocif qu'on lui reproche. Nous n'avons absolument aucune donnée relativement à cette hypothèse. Mais de récents travaux ont solidement établi que le Bruccella abortus a une affinité étroite avec le *Micrococcus melitensis,* découvert par Bruce, qui provoque chez l'homme l'évolution de la Mélitococcie, ou fièvre ondulante; ils ont établi aussi que l'action pathogène des deux microbes est réciproque, c'est-à-dire que le Brucella abortus peut produire la fièvre ondulante, ou une maladie identique, et le Micrococcus melitensis produire l'avortement.

L'infection de ce virus chez l'homme se manifesterait par de la fièvre à courbe ondulée, de l'amaigrissement, de la tuméfaction de la rate, une odeur fétide de la bouche, de la douleur abdominale, etc. Il a fallu 10 mois d'un traitement savant et suivi pour guérir un cas d'infection par le Bacille de Bang, ou Brucella abortus.

Les personnes exposées à la contagion seraient surtout celles qui boivent du lait cru, celles qui soignent les vaches infectées au moment de la délivrance. La maladie transmise à l'homme serait-elle causée par le germe de la Mélitococcie? C'est une hypothèse.

Par contre, il est curieux de noter que la transmission souvent signalée dans certains pays est à peine connue dans d'autres pays où l'avortement du bétail existe sur une grande échelle. Ce n'est pas une raison pour ne pas prendre toutes les précautions hygiéniques contre les risques d'une contagion, rare sans doute, mais possible.

Et l'infection du taureau, comment se manifeste-t-elle?

A sa manière, le mâle infecté, après une phase aigue et indécelable, devient, lui aussi, porteur de germes. Chez lui, ce sont les vésicules séminales et l'épididyme qui constituent les réceptacles du microbe, et l'on conçoit qu'à son heure le taureau puisse contribuer à la diffusion du bacille de Bang.

Mais comment se fait l'infection?

Les formes de la contagion abortive et les voies de la pénétration du microbe dans le corps de la vache sont aujourd'hui bien connues. La contamination d'une étable infectée étant permanente, grâce à la présence des porteurs de germes, il convient de considérer les divers modes de transmission. Encore faut-il assigner son rang à chacun des modes de la contagion naturelle .

Considérée tout d'abord comme particulièrement bien disposée pour recueillir, par souillure directe sur la litière infectée ou au cours de l'accouplement, les germes de la contagion, la *voie vaginale* n'est plus considérée aujourd'hui comme la porte d'entrée essentielle du Brucella abortus. L'ex-

périence a démontré que l'infection n'est obtenue par ce mode qu'au prix d'une infection massive. C'est qu'aussi l'on sait que l'utérus non gravide ne présente pas un milieu favorable à la culture, au développement du microbe de l'avortement. Ainsi s'expliquent et l'échec constaté de la transmission de la maladie par un accouplement infectant, et aussi l'insuffisance—partout reconnue aujourd'hui—de l'antisepsie vaginale, comme moyen prophylactique de l'avortement.

C'est par une voie bien indirecte que s'opère, chez la vache pleine, l'infection des cotylédons. Ainsi que l'a démontré Smith, celle-ci résulte d'un apport microbien par les voies sanguines ensemencées elles-mêmes par la circulation lymphatique, au départ d'une infection par le tube digestif. Autrement dit, l'animal s'infecte en mangeant des aliments contaminés par le Brucella abortus. De l'appareil digestif, le germe passe dans l'appareil lymphatique; de là il tombe dans la circulation sanguine qui vient le porter jusque dans le cotylédon.

La prééminence de l'infection par les voies digestives sur tous les autres modes de contagion est aujourd'hui universellement admise. Ses chances sont telles, dans les conditions de l'élevage à l'étable, qu'elle présente un risque permanent de contagion. Ainsi, dans une étable contaminée, le cultivateur qui prend la même fourche pour nettooyer et soigner; qui nettoie ses vaches et va dans le silo ou sur la tasserie, donne ensuite le foin à ses vaches, ce cultivateur inocule directement le germe à ses animaux, par ses chaussures ou par ses outils contaminés. On ne devrait jamais circuler dans l'allée d'alimention sans nettoyer ses chaussures. Vous direz que ce sont là bien des cérémonies; oui; mais souvenez-vous que la cause de la maladie et son mode d'infection étant connus, il est possible de la prévenir.

Quant à la transmission par le taureau au cours de l'accouplement, couramment admise à une certaine époque, ellle est considérée aujourd'hui, de l'opinion à peu près unanime de tous les chercheurs, comme possible, *mais rarement en cause.*

Le temps qui s'écoule depuis l'infection de l'animal jusqu'à la manifestation de la maladie est connu sous le nom de "période d'incubation". Elle varie avec la résistance de la vache et la virulence du microbe abortif, c'est-à-dire son pouvoir de produire la maladie.

Une vache peut avorter à n'importe quelle période de la gestation, depuis le moment où l'embryon n'a que quelques millimètres jusqu'à ce qu'il soit presque au terme de son développement. Le plus souvent, la vache atteinte d'avortement contagieux avorte vers le septième mois; ensuite le huitième mois et puis le sixième, par ordre de fréquence. Hutyra donne, comme durée de l'incubation de la maladie, 126 jours et Moore donne dix semaines. Il est entendu que si l'infection a lieu tard durant la gestation le Brucella abortus n'aura pas le temps de faire un dommage suffisamment grand pour arrêter la nutrition du foetus et causer son expulsion.

Nous allons exposer maintenant les moyens de lutte à opposer à la maladie de Bang. Les notions qui viennent d'être données et la connaissance approfondie des sources et de la marche de l'infection constituent les bases essentielles d'une prophylaxie rationnelle de la maladie.

Deux éventualités peuvent s'offrir: ou bien on se propose de mettre à l'abri de l'infection un troupeau encore exempt, ou indemne, ou bien on désire assainir une étable déjà infectée.

Dans le premier cas: protection d'un troupeau encore indemne, une vaccination préventive des animaux à protéger serait éminemment indiquée si nous disposions d'une méthode de vaccination à la fois inoffensive et efficace. De l'avis de la presque unanimité des expérimentateurs nous manquons encore d'un tel moyen. Les vaccins inoffensifs, constitués par des microbes tués, utilisés, se révèlent inefficaces, si l'on en juge d'après les statistiques produites en divers pays, et il serait criminel d'user, en milieu indemne, dans l'état actuel de nos connaissances, d'un vaccin constitué par un bacille vivant, fût-il atténué.

On s'attachera donc à écarter du troupeau indemne les deux seuls risques réels de contamination qu'il puisse encourir:

a)—Achat et introduction dans le troupeau d'un animal en état d'infection latente;

b)—Sortie pour divers besoins, comme par exemple les expositions, puis retour dans le troupeau commun d'un sujet lui appartenant.

Achat.—Comment parer au premier de ces risques?

En achetant dans un troupeau où il n'y a pas d'avortement, et, quand la chose est possible, en s'assurant par l'épreuve des qualités de son sang, par la séro-agglutination, de la situation exacte au sujet de la maladie de Bang.

De plus, tout animal nouvellement acheté doit être placé dans un local séparé: c'est la quarantaine. Durant ce temps, il ne doit avoir aucun contact avec les autres animaux du troupeau. La durée de la quarantaine peut varier; elle a pour but de s'assurer si l'animal acheté n'est pas malade.

Le vêlage des vaches nouvellement achetées devra avoir lieu dans une "stalle de maternité", c'est-à-dire, autant que possible, dans un local spécial, indépendant de l'étable, ou tout au moins dans une stalle libre ou *box-stall.* On veillera d'une façon spéciale à se désinfecter les pieds, et, si l'on fait faire l'épreuve d'agglutination, on s'entourera des mesures indispensables de désinfection, jusqu'au jour très proche où la dernière épreuve d'agglutination permettra de posséder une certitude sur la situation sanitaire du sujet.

Toutes ces mesures sont gênantes. Hormis celle de la mise-bas en un local spécial qui demeure impérieuse, on restreindra l'emploi des autres en acquérant exclusivement, pour les besoins de l'élevage, des vaches jeunes, aussi près que possible du terme de leur première gestation. Une épreuve d'agglutination sera pratiquée dès l'achat, et une seconde effectuée du dixième au quinzième jour après le vêlage.

A un même but de simplification répond l'achat des génisses non saillies et de taureaux d'un an, tous sujets jeunes dont on connait l'aptitude à se débarrasser spontanément du Brucella abortus, et qui offrent, de ce fait même, de très réelles garanties de santé. Pour plus de sécurité, on pourrait faire examiner leur sang lors de l'achat.

Sortie.—Non moins que l'introduction de sujets infectés, l'éleveur prévoyant redoutera toute sortie occasionnelle de ses animaux au dehors de l'exploitation. La preuve est faite, tant sont graves les risques de contagion

en certains milieux, que la fréquentation même temporaire de ceux-ci présente un réel péril. On évitera, autant que possible, la présentation au taureau de vaches étrangères à la ferme, la mise au pâturage en commun avec des animaux dont l'état sanitaire n'est pas connu, la contamination du pâturage par l'écoulement vaginal des vaches infectées, excessivement dangereuse, les étables d'exposition, tous moyens certains de contamination.

Tous les moyens de protection autres que ceux que nous venons d'examiner (médicaments de toutes sortes, antiseptie génitale, vaccination, etc.) demeurent inopérants; c'est aux formules énoncées qu'il faut en arriver si l'on veut protéger son troupeau. Les tentatives déjà effectuées établissent tout le prix d'un système prophylactique d'apparence complexe, mais, en réalité, d'application fort aisée pour tout éleveur conscient de ses véritables intérêts.

Tout troupeau infecté était d'abord un troupeau sain. Un jour, une taure a avorté; le cultivateur en a attribué la cause à un coup de corne, à une chute, et n'a fait aucun isolement. L'écoulement vaginal, contenant des millions de germes, a contaminé le plancher de l'étable, et les pieds du propriétaire ont contaminé les aliments. Ainsi, un grand nombre d'animaux se sont trouvés infectés. Avec la multiplication des avortements le cultivateur a commencé à s'émouvoir. Malheureusement, il est trop tard; le mal est fait.

Dans tout troupeau sain, quand un avortement se produit, il faut de toute nécessité isoler la vache, et jusqu'à ce que l'on sache si cet avortement est dû au Brucella abortus, il faut prendre les précautions suivantes;

a)—Ségrégation absolue de la vache.

b)—Destruction par le feu ou l'enterrement du foetus, des membranes foetales et de tout le matériel venu en contact avec la vache.

c)—Désinfection complète de la stalle où s'est produit l'avortement.

d)—Epreuve d'agglutination.

L'assainissement d'un troupeau infecté représente une oeuvre de longue haleine. Les moyens à mettre en oeuvre pour y parvenir ne sont pas uniformes et doivent s'inspirer de l'importance du troupeau, de sa valeur économique et du pourcentage des cas d'infection.

Voyons succinctement les différentes politiques employées.

La politique du laisser-faire ou de l'inaction.—C'est la politique d'un grand nombre de cultivateurs: aucune désinfection, aucun isolement, aucun lavage pour éviter les complications. Rien: la maladie finira bien par mourir d'elle-même.

Cette politique a pour elle la tendance de la maladie à se limiter d'elle-même: phénomène qui a aidé les vendeurs de médicaments anti-abortifs. L'expérience a montré que dans les étables où cette politique a été suivie, la maladie a persisté pendant des années et le nombre d'avortements a été très considérable. Cette politique ne coûte rien, mais elle est ruineuse pour le cultivateur et conduit son exploitation à la banqueroute.

Politique de la vente.—Un certain nombre de cultivateurs, peu scrupuleux, vendent immédiatement toute vache qui avorte. Ils avertissent rarement

l'acheteur qui en paie la façon. Ce système, s'il est avantageux pour le vendeur, est néfaste pour l'acheteur.

Politique de l'abatage.—C'est la vente pour la boucherie des animaux reconnus affectés. C'est une pratique à laquelle sacrifient, sans discernement, tant d'éleveurs dont le troupeau est entamé par l'avortement.

Que penser d'un tel moyen?

Avec beaucoup de chercheurs, j'estime qu'il n'est pas expédient de se défaire d'animaux encore en bonnes conditions d'exploitation pour cette seule raison qu'ils ont avorté. La vente ou la liquidation de ces sujets intervient d'ordinaire au moment où, après avoir avorté une ou plusieurs fois, ils parviennent à un état de prémunition (vaccination) bien assise qui fera d'eux des reproducteurs satisfaisants. Les remplacer par d'autres, non prémunis, non vaccinés naturellement, revient à alimenter la contagion qui décime l'étable.

Politique de la vaccination.—Devant l'impuissance de la thérapeutique curative, du traitement médicamenteux, on a essayé la vaccination. Il n'est pas de maladie microbienne qui n'ait fait l'objet de tentative de vaccination, et l'avortement n'a pas échappé à cette règle. Nombre de chercheurs se sont attachés à l'étude de l'immunité contre le Brucella abortus et à la possession d'un vaccin favorable. On a essayé de vacciner les animaux avec des microbes vivants, avec des microbes morts; de nombreux produits ont été mis dans le commerce avec des résultats discutés et incertains. De fait, la preuve de l'efficacité de la vaccination n'est pas encore établie, et on ne saurait dire actuellement que l'on possède un procédé de vaccination utile contre l'avortement. Si, sans aller jusqu'à la conception de la banalité de la cause de l'avortement, jusqu'à la théorie de Williams, on veut bien admettre que ses causes en sont multiples, on conçoit aussitôt qu'une méthode de traitement spécifique, c'est-à-dire basée sur une seule espèce microbienne, est vouée à un insuccès et que ses résultats sont au moins incomplets. De plus, il faut se souvenir qu'en matière de maladie de Bang, qui est une maladie chronique, il ne saurait être question d'immunité vraie. Cependant, comme l'indique Rinjard en une formule heureuse, "si l'on s'en tient aux faits observés "en milieu infecté, en prenant l'accident de la gestation comme seul critérium "de l'infection, tout se passe comme si un état d'immunité se constituait, "puisqu'au bout d'un certain temps l'animal infecté cesse d'avorter."

Il n'y a ici qu'apparence d'immunité, et le vêlage à terme n'est pas une preuve de la libération complète de l'organisme. En réalité la vache qui vient d'avorter reste porteur de germes dans son pis et dans ses ganglions; comme telle, elle n'est plus susceptible d'une surinfection par des germes d'introduction nouvelle.

La valeur de la vaccination anti-abortive est encore fort discutée. On a été jusqu'à dire qu'elle est dangereuse, en ce sens que la vache vaccinée élimine le germe par son lait et constitue un danger permanent pour les autres vaches. Cette objection n'est pas sérieuse, parce que lorsque la vaccination est résolue on l'emploie sur toutes les vaches, souvent, il faut l'avouer, sans discernement, car toutes les vaches ne sont pas prêtes à être vaccinées en même temps.

On a aussi accusé la vaccination d'être une cause de stérilité.

De plus, une vache vaccinée réagit à l'épreuve du sang et ne peut être exportée.

La vaccination contre l'avortement n'est donc pas à recommander.

Politique de la séro-agglutination fréquente. Disons immédiatement ce que l'on entend par *séro-agglutination, épreuve d'agglutination, épreuve du sang* (blood test).

Cette épreuve est basée sur ce phénomène que tout animal infecté réagit en produisant des contre-poisons, des anticorps, comme on dit. Parmi ces substances il en est une que l'on nomme: *des agglutinines.* Elles ont la propriété d'agglutiner, c'est-à-dire de réunir les microbes propres contre lesquels elles ont été élaborées.

Prenons une suspension de microbes de l'avortement provenant du lavage, avec de l'eau physiologique, de cultures. Nous aurons un liquide opalescent. Prenons ensuite une petite quantité de sérum sanguin d'un animal sain et mélangeons-les; le liquide va rester opalescent, parce qu'un animal sain n'a pas d'agglutinines contre l'avortement. Faisons la même opération avec le sérum sanguin d'un animal infecté du Brucella abortus; au lieu d'avoir un liquide opalescent, nous aurons un liquide clair, transparent, avec un dépôt blanchâtre au fond de l'éprouvette. Le sérum de l'animal infecté a des agglutinines qui ont réuni les germes.

Voici comment on procède en suivant cette politique.

On fait l'examen du sang de tous les animaux de l'étable; cet examen permet de dénombrer avec une exactitude suffisante le pourcentage des sujets infectés. Les réacteurs sont séparés des non-réacteurs. Quand la chose est possible, ils sont maintenus dans une étable séparée. C'est là la grosse difficulté: la ségrégation complète est presque impossible sur la plupart des fermes. S'il n'y a qu'un petit nombre d'animaux qui réagissent, il est à conseiller de sacrifier en hâte les sujets porteurs d'infection. Si un grand nombre d'animaux réagissent, il faut considérer le troupeau comme infecté et employer les procédés connus de prévention, comme l'isolement des vaches avortées, la destruction des avortons et des enveloppes, la désinfection, les précautions hygiéniques des outils, des chaussures, l'hygiène sexuelle des vaches, pour éviter les complications: autant de moyens qui donnent les meilleurs résultats s'ils sont employés avec discernement et persévérance.

Queles objections peut-on opposer à la séro-agglutination?

Les suivantes;

1.—Nous n'avons aucun traitement à appliquer aux réacteurs quand ils sont connus.

2.—Une réaction négative n'indique pas que la vache n'avortera pas

3.—Une réaction positive n'indique pas que la vache avortera.

4.—La difficulté d'avoir une ségrégation complète.

5.—La déception causée par l'avortement d'une vache à réaction négative, avortement qui peut avoir pour cause une infection autre que celle produite par le Brucella abortus.

Cette infection autre que celle du Brucella abortus peut produire 40% d'avortements chez les non-réacteurs.

D'après les données actuelles de la science, il n'y a aucun médicament susceptible de guérir une vache infectée. Si l'on pouvait trouver ce médicament, la lutte contre l'avortement se simplifierait: il ne s'agirait que de trouver les sujets infectés par la séro-agglutination et de les injecter.

La science n'a pourtant pas failli à son devoir. Elle a scruté l'avortement, mais elle n'a pas encore abouti aux résultats espérés; elle laisse encore l'éleveur dans l'attente de moyens sûrs pour lutter contre la maladie. Avec le travail gigantesque qui se fait dans toutes les parties du monde, espérons qu'un jour, qui n'est peut-être pas éloigné, elle aûra un traitement infaillible contre ce fléau.

Quelles sont les complications de l'avortement?

Non seulement la Maladie de Bang cause des pertes par la diminution dans la production laitière, mais elle a souvent des complications graves parmi lesquelles il faut citer: la rétention du placenta ou non-délivrance, la septicémie, la stérilité.

Je ne veux pas m'étendre sur les causes ni le traitement de la non-délivrance; je dirai simplement que c'est un accident grave dont le traitement est essentiellement du ressort du vétérinaire, parce que tous les cas de non-délivrance ne doivent pas être traités de la même manière. Chaque cas demande une étude avant d'appliquer le traitement.

De plus, le traitement a des conséquences sérieuses sur la fécondité future de l'animal. Très souvent, après cet accident, il persiste dans l'utérus une infection qui conduit à la stérilité.

En elle-même, la stérilité n'est pas une maladie; elle indique une infection ou une anomalie quelconque de l'appareil reproducteur, et elle se manifeste par le fait que la vache, après plusieurs accouplements, ne peut pas être fécondée, ou ne peut pas produite un embryon. Strictement parlant, il y aurait peut-être lieu de distinguer entre la non-réussite ou l'insuccès de la fécondation, et la mort prématurée de l'ovule fécondé ou de l'embryon. Pratiquement la chose n'est pas possible. Il est certain qu'il y a beaucoup d'avortements précoces qui se produisent sans qu'on les voie, et il est fréquent d'entendre dire à des éleveurs: "Je croyais bien que telle ou telle vache était pleine; "mais "après plusieurs mois d'une prétendue gestation, la vache est revenue en "chaleur." Il est possible que la vache ait été fécondée et que le produit de la fécondation ait été rejeté à l'insu du propriétaire.

La stérilité peut être due à bien des causes, dont la plus commune est l'infection. Cette infection n'est pas spécifique et peut envahir et les vaches et les taureaux. La Maladie de Bang, en soi, ne cause pas la stérilité, mais elle prédispose la vache à d'autres infections.

Cette infection de l'appareil reproducteur joue un rôle prépondérant sur la santé des futurs produits quand la fécondation a lieu. Il n'est pas rare, dans les étables où sévit l'avortement, de voir naître des veaux faibles, qui meurent peu de temps après la naissance. Ces veaux ne sont autre chose que des produits infectés avant la naissance. Cette infection prénatale est appelée *Septicémie* des veaux. Elle indique que le foetus s'est développé dans un milieu infecté. En effet, si au moment de la fécondation l'utérus est infecté et si la fécondation a lieu en dépit de cette infection, le produit se développe

en milieu septique. Le foetus avale toujours une certaine quantité des liquides qui l'entourent et qui contiennent des germes. De l'appareil digestif ces germes passent dans le sang du foetus et causent la septicémie.

Peut-on prévenir cette infection?

Il est reconnu que la septicémie des veaux, de même que l'arthrite des poulains, sont des maladies dont la prévention est facile.

Des travaux récents ont établi que plus de 50% des juments examinées présentent, le neuvième jour après le poulinage, une infection streptococcique de l'utérus. Cette infection empêche la fécondation puisqu'il n'y a pas plus de 25% des juments saillies le neuvième jour qui conçoivent. De plus, dans nombre de cas, cette infection cause l'avortement. Enfin, elle est la cause de la maladie connue sous le nom *d'arthrite* des poulains.

L'arthrite des poulains et le septicémie des veaux sont deux maladies qui se préviennent AVANT LA SAILLIE.

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A Note on the Biological Control of Root Rots of Cereals

An article by G. B. Sanford and W. C. Broadfoot, Dominion Laboratory of Plant Pathology, University of Alberta, Edmonton, Canada, will be published in the April issue of *Scientific Agriculture* on the above subject. From experiments made during the past year or more, it has been proven that either the living cultures of many soil-inhabiting bacteria, fungi and actinomycetes, or the filtrates of these, exert a suppressive effect on the pathogenicity of *Ophiobolus graminis*, an extremely virulent fungus causing the take-all disease of wheat. This effect varies from complete control of the disease on the one hand, down to actually intensifying it on the other, according to the organism or filtrate concerned. The separate effects of sixty-five individual cultures of micro-organisms and of their filtrates were studied in sterilized soil in pot culture. Among those which completely controlled the pathogene were *Botrytis cinerea, Penicillium* spp., *Bacillus cereus, Bacterium faecalis alkaligenesis*, and others. The living cultures sometimes gave control, whereas the corresponding filtrate did not always do so. The reverse of this was also true.

CONCERNING THE C.S.T.A.

The March Issue of Scientific Agriculture

This month's issue of the official journal of the C.S.T.A. might be classed as a "Prairie number". In making up the magazine, the Managing Editor tries to arrange for a variety of articles appealing to the different groups, and for the representation of different sections of the country, if not every month, at least periodically. The order in which articles are received, urgency of the need for publication of any certain piece of research, and the limits of space requiring a set number of pages must also be taken into consideration.

When it was seen that the articles for this month all had their origin on the prairies, with the exception of the French article, it was decided to present this issue as a picture of the problems facing the west today. The interest in fertilizers, in crop purity, and in seed germination are each represented by an article, while an important discovery in the control of a root rot of wheat is announced in a brief note. The article on economics gives an unbiased picture of the wheat situation. The report of the Western Canada Society of Animal Production gives a general review of the problems and progress of the animal industry.

The Editor makes no apology for presenting a "sectional" number of the magazine this month. He only wishes that all numbers carried the appeal to the general membership that he feels this one will.

Grindley Portrait to be Painted by E. Wiley Grier, P.R.C.A.

The committee in charge of the Memorial for the late General Secretary, Mr. Fred. H. Grindley, has been very fortunate in securing the services of the well known portrait painter, Mr. E. Wiley Grier, President of the Royal Canadian Academy. Mr. Grier during the past few years has painted many prominent Canadians, among the latest being the Hon. N. C. Rowell, K.C., whose portrait represented this artist at the annual opening of the National Gallery in January. The portrait of Dr. J. B. Reynolds done by Mr. Grier is considered the best of the many portraits at the Ontario Agricultural College.

Local executives have been advised that a portrait fund should be raised immediately and steps will be taken shortly by each executive to place the details of this fund before their membership. It has been decided that for the time being this will be the only memorial fund raised. A discussion of a further memorial to take the form of some annual recognition of Mr. Grindley's services will take place at the convention in June. Several alternative plans have been suggested and the Memorial Committee will report on these. In the meantime it is hoped that the response to the portrait fund will be immediate and generous. All members who subscribe will be given a copy of the portrait suitable for framing. The formal unveiling will take place at the annual convention at Guelph and will hang permanently at the Society headquarters. A three-quarter length size 40 x 30 has been selected as suitable for the room. An easy sitting position with the magazine in the right hand has been taken as a characteristic pose, and the light will fall from the left as it does in the lounge room. Mr. Grier is very enthusiastic over the prospects for a good portrait.

Nominations, Elections and Reports of Committees

Nominations for Dominion Officers for the next Society year must be in the hands of the General Secretary by the 15th of March. Ballots will be prepared and sent to members immediately. In order to facilitate the publication of the programme for the next convention, voting will close on the 15th of April instead of the 30th as heretofore. While the by-laws state that nominations must be in by the 15th of March there is no date set for the closing of the balloting. It is felt, however, that one month should be ample time for the distribution and return of the ballots.

The standing committees have been requested to have their reports in the hands of the General Secretary by the 15th of May in order that they may be prepared in printed form for the convention. Local committees which are reporting to standing committees should see that their reports are forwarded within a very short time.

New Live Stock Commissioner

Following the resignation of Mr. H. S. Arkell, Mr. G. B. Rothwell has been appointed Acting Live Stock Commissioner. Mr. Rothwell was formerly Dominion Animal Husbandman and has had wide experience in the Experimental Farm System. He is well known to the live stock men of the whole Dominion and his appointment has brought forth many expressions of satisfaction and confidence.

Mr. H. S. Arkell, former Commissioner, has entered the marketing field as General Superintendent of the Canadian Live Stock Coöperative Limited with headquarters at 316 Bridge St., Montreal. Mr. Arkell's heart is in this work and it is expected the organization will make excellent progress under his guidance. His home remains at Britannia Heights, near Ottawa.

Scholarship Funds for 1931-32

At the present time no scholarship funds are available for members of the C.S.T.A. for the next academic year. The Society has gone into this matter very thoroughly with different organizations and individuals. While these have expressed great sympathy with the work and entire satisfaction with the results to date, general business conditions will not permit the distribution of such funds this year. We have good reason to believe that when conditions improve we will again be able to offer scholarships to C.S.T.A. members.

Agricultural Economics Branch Starts Publication

The Agricultural Economics Branch of the Dominion Department of Agriculture has inaugurated the publication of a monthly bulletin to be known as "The Economic Annalist". This is intended to give accurate information to extension and administration officials and others who may be interested. Any who have not received this publication and desire to should address their requests to Dr. J. F. Booth, Commissioner, Agricultural Economics Branch, Department of Agriculture, Ottawa.

Notes and News

H. U. Western (Toronto '22) has been appointed Superintendent of the Fort William Industrial Farm. Mr. Western has been with the Soldier Settlement Board for the past eight years.

A. E. Richards (British Columbia '23) formerly Supervisor of Illustration Stations for British Columbia has been appointed Economist in the Agricultural Economics Branch, Ottawa.

E. C. Hallman (Toronto '02), Farm Manager, Oliver Government Farm, North Edmonton, has changed his address to 10730-107th St. Edmonton, Alberta.

Robert Raynauld (McGill '26), General Manager of the Société d'Expertise Agricole, has his office at Room 316 Amherst Building, 1010 Ste. Catherine St. E., Montreal. This was given last month as his house address.

O. McConkey (Toronto '17), Lecturer in the Field Husbandry Department at the Ontario Agricultural College, has returned to Guelph after two years of research at Cambridge University for his Ph.D. on plant sciences with particular attention to pasture improvement problems. He made a study of plant breeding and grassland agronomy methods at the Welsh Plant Breeding Station, Aberystwyth and in the Scandinavian Countries and Germany. During his stay in England he prepared a bulletin for the British Government on Recent Advances in Pasture Management.

R. Barbin (Laval '13) has been promoted to the position of District Drainage and Water-Courses Inspector with residence at 274 rue Bouthillier, St-Jean, P.Q.

J. C. Fuller (Toronto '15), District Agriculturist in the Dominion Land Settlement Branch, Toronto, has been transferred to Winnipeg. His office address is Commercial Building, Winnipeg, Man.

I. F. Stothers (Toronto '23) Loan Officer, C. S. Gunn Company Ltd., Saskatoon, was married on February 2nd to Miss Jennie L. Thorpe of Wilkie.

R. Summerby (McGill '11), Professor of Agronomy, Macdonald College, is on leave of absence for six months. He has gone to England to study Biometrics with Dr. R. A. Fisher of Rothamsted and get in touch with agronomic work in progress there and at other stations in the Old Country.

G. W. Muir (McGill '14) Chief Assistant, Division of Animal Husbandry, Central Experimental Farm, Ottawa, is Acting Dominion Animal Husbandman in succession to Mr. G. B. Rothwell.

C. W. Leggatt (Toronto '21), Supervising Analyst, Dominion Seed Branch, Toronto, has been elected President of the Association of Official Seed Analysts of North America. It is expected that this Association will hold its annual meeting in Toronto during the week of August 10th, 1931.

E. T. Chesley (Toronto '22) is doing publicity work with the Crops, Coöperation and Markets Branch, Ontario Department of Agriculture, Toronto.

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G. R. Paterson (Toronto '24) has been appointed Feed and Fertilizer Specialist in the Crops, Coöperation and Markets Branch, Ontario Department of Agriculture, Toronto.

F. G. North (Toronto '23) is Representative for the Toronto Tractor and Machinery Company and is located at Apartment 22, 715 Main St. E., Hamilton, Ont.

R. H. Thexton (Manitoba '23) who was taking a graduate course at the University of Wisconsin, was recently appointed Junior Bacteriologist at the Central Experimental Farm, Ottawa. He will work under Dr. Lochhead.

A. T. Elders (Manitoba '24) has returned to his duties at the Manitoba Agricultural College after spending the last quarter at the University of Minnesota pursuing graduate work under Dr. H. K. Hayes.

Macdonald College of McGill University has announced a course in Entomology leading to the degree of Ph.D. This has been approved by the Faculty of Graduate Studies at McGill University.

The British Columbia Branch of the C.S.T.A. holds an annual fall meeting including group sessions and a general meeting. This year the Animal Science Group and the Plant Science Group both arranged attractive programmes and several very excellent papers were presented. The general meeting included discussions on marketing and education and included reports of the International Conference of Economists at Cornell University and the C.S.T.A. Convention at Wolfville. The ladies were invited to be present at a banquet following which the party adjourned for an indoor golf tournament. This type of programme is to be highly commended and the General Secretary and the Dominion President on their trip to British Columbia last fall found that it had a great effect in keeping up the interest of the widely scattered membership in this province. Also, the General Secretary thoroughly enjoyed his round of golf after the meeting in Vancouver last fall and begs to report that since then he has never had anything like the good luck which enabled him to hold up the honour of the East on that occasion.

New Members

The following applications for regular membership have been received since January 1, 1931:

Banks, E. A. H. (Toronto, 1930, B.S.A.), Vineland Station, Ont.
Barr, A. M. (Toronto, 1930, B.S.A.), Kemptville, Ont.
Chagnon, B. (Oka, 1927, B.S.A.), Victoriaville, P.Q.
Dench, Frank Q. (Toronto, 1929, B.S.A.), Renfrew, Ont.
Duncan, C. C. (Toronto, 1916, B.S.A.), Vineland Station, Ont.
Lashley, N. A. (Toronto, 1928, B.S.A.), Alliston, Ont.
McGugan, A. (Toronto, 1926, B.S.A.), Simcoe, Ont.
MacIntosh, J. M. (Toronto, 1916, B.S.A.), Sault Ste. Marie, Ont.
Peech, M. (Saskatchewan, 1930, B.S.A.), Saskatoon, Sask.
Riddell, W. K. (Toronto, 1923, B.S.A.), London, Ont.
Toole, Arnott A. (Toronto, 1912, B.S.A.), Fort William, Ont.

BOOK REVIEW

THE PENICILLIA, by Charles Thom, Principal Mycologist, Bureau of Chemistry and Soils, U. S. Department of Agriculture. (Published by Williams and Wilkins Company, Baltimore, Md., U.S.A. $10.00).

This is a book we have been waiting for and looking forward to for more than twenty years. How often during that period could we have used it to advantage, not only in private investigations but in class laboratories where students were isolating and attempting to identify the various moulds developing on their cultures made from various food substances! We knew that Dr. Thom was working on it, and often wondered when it would be available. Now we have it, and after carefully going through it we understand why its publication was so long delayed. The book represents a herculean task, the cleansing of an Augean stable.

The genesis of the work dates back to 1904 when the author, conducting cheese investigations at Storrs Agricultural Experiment Station, collected a miscellaneous lot of Penicillia, Mucors, Aspergilli, Fusaria, Trichoderma, Monilia, Oidium, Oospora, etc., which he took to Harvard University for study. Professor Thaxter one day looked the lot over and exclaimed "Why bother with these miserable little things? Why not do something worth while, straighten out Penicillium! It is an awful mess." Thom accepted the challenge, and now he has won out, although he modestly says "At best, it is possible to present only a very unsatisfactory scheme of classification of this difficult group."

He lists and describes over four hundred species of Penicillium, and over two hundred more of closely allied species found in Gliocladium, Scopulariopsis, Paecilomyces ,etc., many of which appear in the literature described as Penicillia. In his bibliography he lists over two thousand references.

In addition to covering all the literature on the subject both old and new, the author obtained culture collections from all recognized living authorities, including Biorge of Louvain, Westerdijk of Bearn, Wehmer of Hanover, Westling of Stockholm, Dale of Cambridge, Brierly of Rothamsted, Kidd of London, Raistrick of Ayreshire, Putterill of Capetown, Van der Bijl of Pretoria ,Hansford of Jamaica, da Fonesca of Rio de Janeiro, Saito and Naganishi of Manchuria and many colleagues in the various bureaux of the United States Department of Agriculture. Each year many thousands of cultures were made, examined, checked up and recorded by Thom and his assistants. The volume of six hundred and forty-four pages is the condensed expression of the author's opinions regarding the Penicillia based on this enormous piece of investigation.

Notwithstanding the size of the book, every division, every chapter, every paragraph, every sentence is concise, marked by the utmost brevity consistent with clarity and adequate presentation of essentials. The various keys, so far as we have tested them, fit the locks for which they were made and open them with smoothness and ease. The indices are all that could be desired. In the species index is listed about every species of mould that has ever been described as a Penicillium, whether it was true to type or not.

The species descriptions given are all from observations made on cultures growing on laboratory culture media, the cultural characters as well as microscopical features being presented. An example taken at random is as follows:

"406. *P. rugulosum Var.* atricolum (Bainier?) Thom., n. var.

Colonies upon Czapek's solution agar small, restrictedly growing, about 1 cm. in diameter in ten to twelve days, gray-green to gray with outer area white or nearly so and a submerged band perhaps 1 mm. wide; reverse uncolored in Czapek plates, becoming orange upon corn meal; conidiophores 100 to 200 microns long; penicillus variously monoverticillate, biverticillate and symmetrical or with metulae and sterigmata in the same verticil; sterigmata 8 to 9 microns in length, lanceolate; conidia about 3.5 by 2 microns, rough.

Culture 4640.439 as received in the Bainier collection was labeled *P. atricolum* and is made the type. The relations among the many variant strains assigned by us to *P. rugulosum* have not been worked out fully. Strains with white margin and colorless reverse as in Bainier's culture are fairly common. Most of them show tardily a development of the orange colors in reverse and the yellow aerial hyphae of *P. rugulosum*. This varietal name may be justified by these differences."

We fail to see where the above could be improved, either in material presented or method of presentation, for the purpose for which it is intended. We have read through a considerable number of the species descriptions and find them all up to the above standard.

Mr. Thom has our very best thanks for this masterly piece of work.

D.H.J.

Plans for the Guelph Convention

A meeting of the Ontario Committee in charge of the Eleventh Annual Convention of the C.S.T.A. was held at Hamilton on February 26th. There was a good attendance and sub-committees presented excellent reports on the progress they had made to date. A great deal has been done to simplify the handling of the convention and it is expected that there will be no difficulty whatever in taking care of the crowd. A special programme is to be printed early in April announcing the names of the speakers and the general programme. This souvenir programme, which will be very attractive, need not be brought to the convention as a smaller detailed pocket-size programme which can be carried easily will be furnished. Members of the C.S.T.A. and friends should plan to make the week of June 22nd a part of their holiday. The programme will not be too heavy and the expenses will be light. While the names of special lecturers can not yet be announced some of the groups have indicated their choice and we are in the process of securing these men if at all possible. Further plans are under way for many Class Reunions on the afternoon and evening of June 26th and the general Alumni Day on June 27th.